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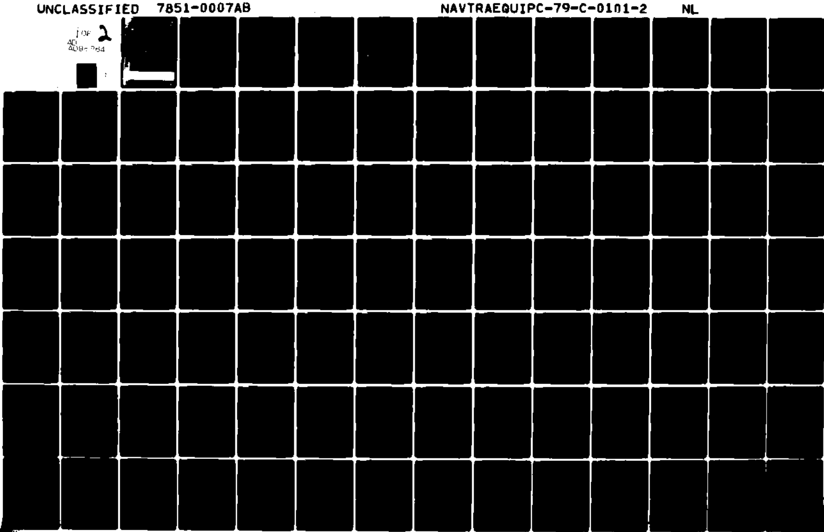

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This report describes the results of a training effectiveness evaluation of the LSO Reverse Display portion of the A7E Night Carrier Landing Trainer. Evaluation methods included survey and observation. A syllabus for Phase II and III LSO training with the LSO Reverse Display is included. An annotated bibliography on LSO is also included.

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FOREWORD

Due to limitations of time and personnel, a comprehensive evaluation of the LSO Reverse Display (LSORD) portion of device 2F103 was not completed. Instead this report provides results and interpreatations of questionnaire data from LSO's exposed to the LSORD as a way to define its training characteristics. There are appendices in this report which make it a valuable handbook for evaluation of the LSORD. A proposed syllabus for phase II and phase III LSO training is included along with an annotated bibliography of LSO articles and reports. This report can serve as a reference, therefore, for the Navy's decision on how to proceed with LSO training devices.

R. BREAUX, Ph.D.
Scientific Officer

PREFACE

The authors are indebted to many people within the Navy's LSO community who have contributed to this research effort. Of particular note is the effort of LT Don Bullard (VA-122, NAS Lemoore) whose inputs had a significant influence on all aspects of the study results presented in this report. Without his knowledge of the LSO Reverse Display and exercise of the device in LSO training, this report would have very limited orientation to the user (LSO) community. His influence upon the syllabus development effort was especially noteworthy. LCDR Bill Gruver (OINC, LSO Phase I School) provided outstanding coordination of study interaction within the LSO community, as did his successor, LCDR Jerry Singleton. LT "Barney" Rubel (CVW-7, NAS Cecil Field) was also very instrumental in supporting the on-site observation of LSO training in the LSO Reverse Display.

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SECTION I

INTRODUCTION

Recently the Navy procured the Landing Signal Officer Reverse Display (LSORD), a Landing Signal Officer (LSO) training station which is a part of the A7E Night Carrier Landing Trainer (Device 2F103). Since there was significant LSO involvement in its development and initial testing, there was a high level of confidence in its value to LSO training. However, confirmation of its training effectiveness in the field was desired. Additionally, the Naval Training Equipment Center (NAVTRAEQUIPCEN) saw the field evaluation of this device as an opportunity for continued research into LSO training system requirements. Thus, these two factors provided the impetus for the study which is the topic of this report.

The results of this study confirm that the LSO Reverse Display is a valuable addition to the LSO training program. The highlights of the device are simulation of pitching deck conditions, provisions for LSO talkdown, and use of the Manually Operated Visual Landing Aid System (MOVLAS), three aspects of the LSO job which are inadequately addressed in the existing training program. This report also provides several recommendations for improving the effectiveness of the device through modification and through guidance for its utilization. The results of this study also have provided some insight into requirements for a more sophisticated LSO training system.

Subsequent sections of this report describe study objectives, the device itself, and study activities, as well as the findings and recommendations resulting from study activities. Several appendices are also included to provide amplification of study results, foremost of which are syllabi for utilization of the LSO Reverse Display in Phase II and III LSO training.

SECTION II

OBJECTIVES

Procurement of the LSO Reverse Display was considered a significant step toward improving LSO training. Its capabilities to simulate the LSO "waving" environment and allow LSO/pilot interaction for night carrier landing situations showed great potential for enhancing LSO skill acquisition. It was envisioned as a vehicle for instructionally controlled exposure and experience with many complexities of the LSO job such as MOVLAS, pitching deck and poor weather conditions. Its utilization was seen as being analogous to the employment of flight simulators to support pilot training. The need to confirm these expectations was recognized by NAVTRAEQUIPCEN and influenced the initiation of this study.

Additionally, there has been extensive research by the NAVTRAEQUIPCEN into LSO training requirements and training system concepts over the past several years. References to reports resulting from those efforts appear frequently in this report. This research has been oriented toward the specification of an LSO training system (or systems) which can accelerate the acquisition of LSO skills, and thus increase the number of skilled LSOs available to support fleet operations. Prior to procurement of the LSORD, studies of LSO interaction with training systems had been restricted to the laboratory environment. The LSORD thus provided NAVTRAEQUIPCEN with a valuable opportunity to investigate automated, interactive LSO training system concepts in an operational environment as a part of this study.

In view of these factors several objectives were established for this project:

a. Assess the effectiveness of the LSORD in its support of LSO training.

b. Identify potential enhancements to the LSORD.

c. Compare LSORD training efffectiveness to other device and method alternatives.

d. Delineate guidance for effective utilization of the LSORD in terms of syllabus and instructor functions.

e. Revise prior estimates by Hooks and others (1978)[1] of capabilities needed in an LSO training system as substantiated by study results.

Several major activities were planned to support these objectives. The first was a comprehensive literature search concerning the LSO and training system evaluation. Then several concurrent activities were planned, including a limited transfer of training study, survey of the LSO community and

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1. Hooks, J.T., Butler, E.A., Gullen, R.A. and Petersen, R.J., Design Study for an Auto-Adaptive Landing Signal Officer (LSO) Training System, Technical Report, NAVTRAEQUIPCEN 77-C-0109-1, Naval Training Equipment Center, 1978.

observation of LSORD training operations. Following these, syllabi were to be developed for LSORD employment within Phase II and Phase III LSO training. Later in the report, study activities are described in detail.

SECTION III

THE LSO REVERSE DISPLAY

As explained earlier, the LSO Reverse Display (LSORD) is an LSO training station which has been added to the A7E Night Carrier Landing Trainer (NCLT), Device 2F103. The device is installed at two Navy sites, NAS Lemoore, California, and NAS Cecil Field, Jacksonville, Florida. Figure 1 depicts the general layout of the 2F103 complex.

The LSO training station is a light-proof and sound-proof enclosure which houses a two-cathode ray tube (CRT) visual system, an LSO instrument console, normal LSO workstation control items and control units for training station operation. Figure 2 is a cutaway view of the student station. There is an instructor station which serves both the LSORD and the NCLT. The instructor console contains a single CRT for viewing both the LSO and pilot approach scenes and controls for operating the LSORD. Table 1 provides a functional listing of LSORD features. The following paragraphs provide an overview description of the device and its operation.

From the LSO training station (fondly called the "igloo"), the trainee can "wave" simulated night carrier approaches "flown" by the pilot in the NCLT. The LSO view is provided by two CRTs covering approximately an 80 degree field of view of the carrier deck and horizon. Figure 3, from Lacy and Meshier (1979)[2], depicts a portion of the LSO view including the A7 aircraft image. The wall of the training station enclosure has an extended horizon line which matches that portrayed on the CRTs. The view of an approaching aircraft is maintained within the CRTs throughout the approach (including touchdown and bolter) by a computer driven "scene rotation" process. The visual system can depict carrier deck motion. As the aircraft approaches the carrier, an outline of the aircraft shape gradually appears on the display. Engine sound, as heard from the LSO platform, is provided and is correlated to range and to the pilot's throttle positioning. Background carrier deck noises are also available. For task interaction the trainee has the normal LSO control instruments: radio handset, Manually Operated Visual Landing Aid System (MOVLAS) and "pickle." For instructional interaction there are several elements displayable to the trainee. There is a green crosshair depicting optimum glideslope and lineup, and a red crosshair during rerun showing MOVLAS positioning. Alphanumerics which delineate approach results are available. During rerun, graphic plots of aircraft approach dynamics are available. The trainee has communications with the NCLT pilot and the instructor console, through the radio handset and loudspeaker located in the enclosure. Inside the enclosure are controls for operating several of the LSORD features.

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2. J. W. Lacy and C. W. Meshier, Development of a Landing Signal Officer Trainer, Proceedings First Interservice/Industry Training Equipment Conference, NAVTRAEQUIPCEN IH-316, 1979, 79-80.

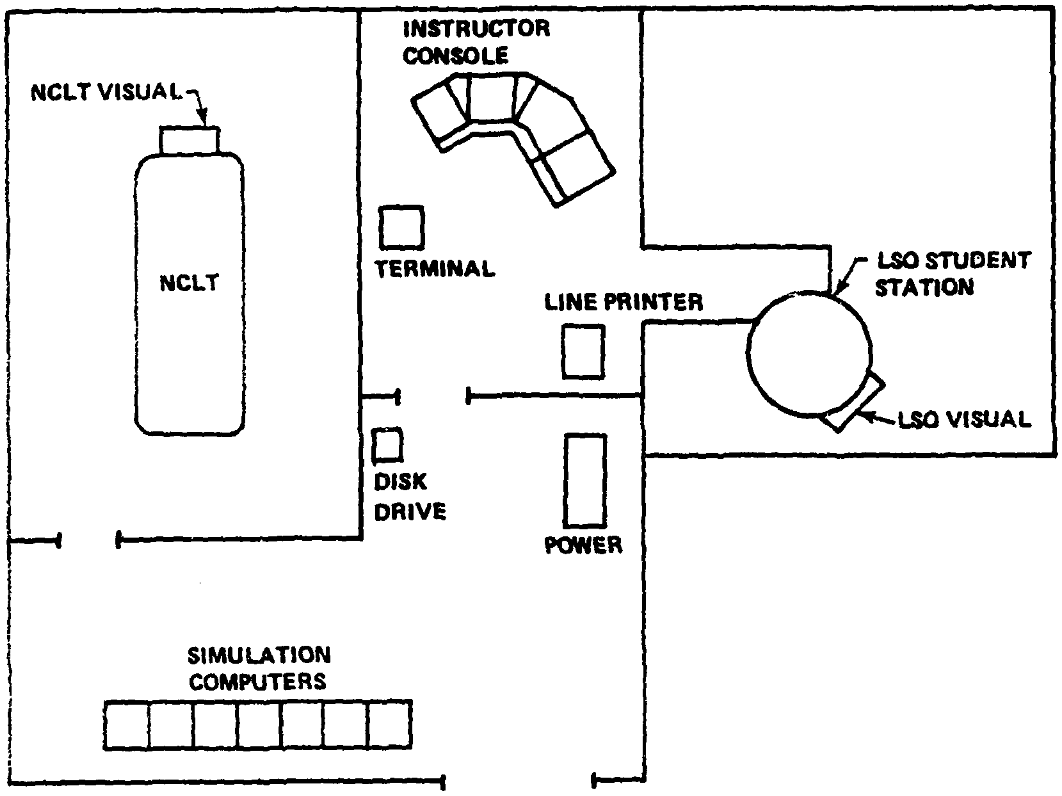

Figure 1. General Layout of NCLT/LSORD

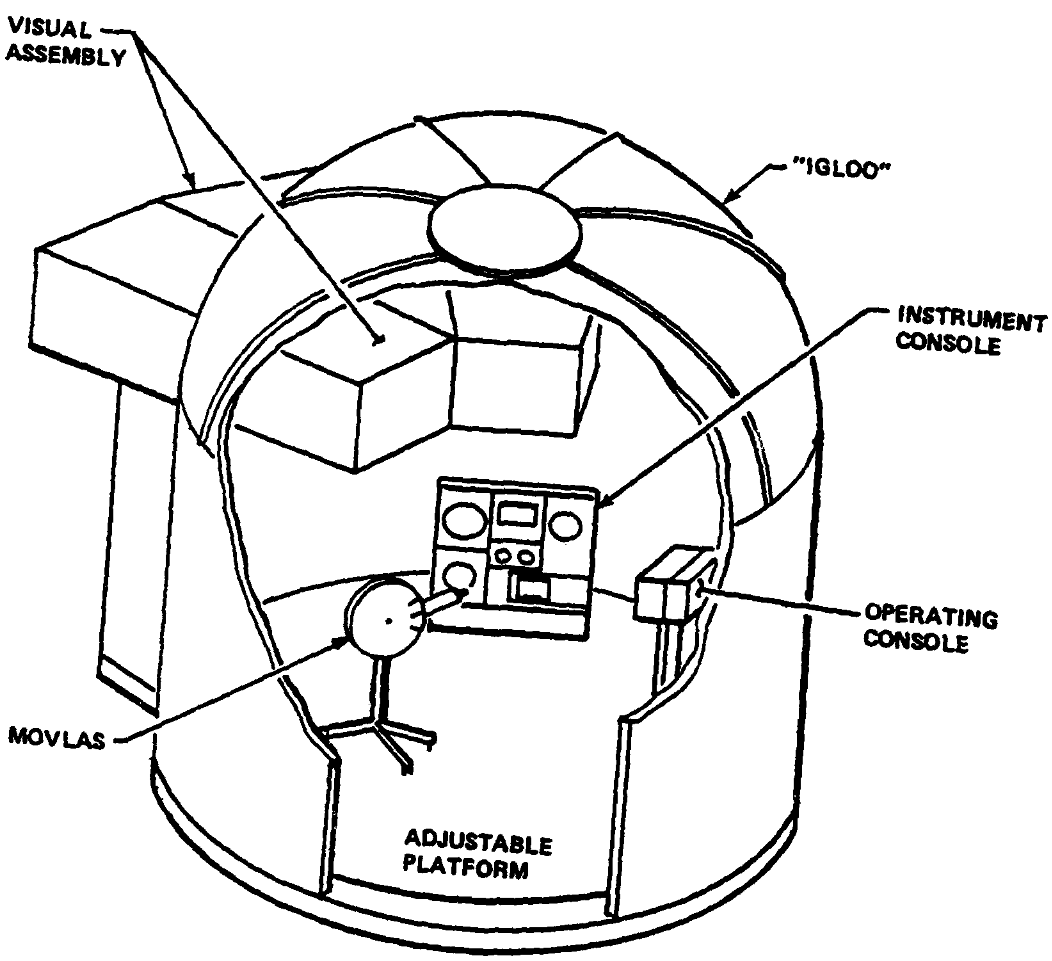

Figure 2. Cutaway of LSORD

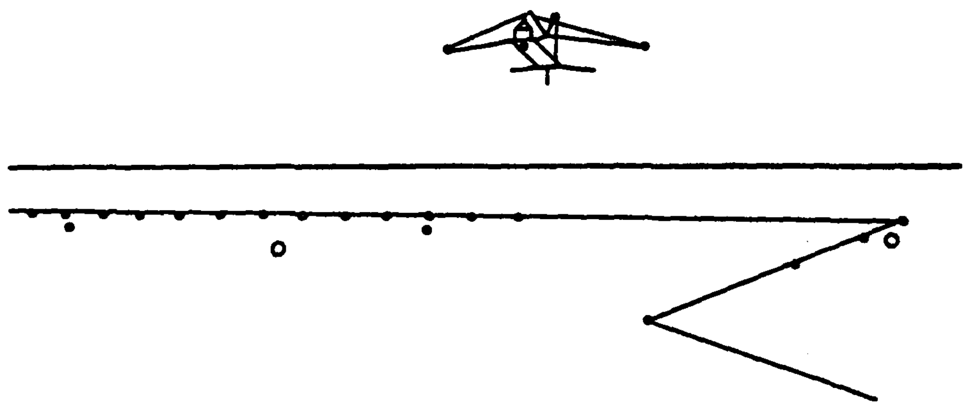

Figure 3. LSORD Approach Scene

TABLE 1. LSO REVERSE DISPLAY FEATURES

Student Station ("igloo")
  Environmental Conditions:
  - Carrier approach background scene - deck outline, horizon, plane guard destroyer, deck status light, sky/stars, deck motion, scene rotation
  - A7 visual simulation - exterior lighting, approach lights, outline
  - LSO instrument console - hook to ramp indicator, lens roll and basic angle indicators, wind speed and direction indicator, MOVLAS repeater
  - Audio simulation - aircraft engine, deck sounds

  LSO Controls:
  - "pickle"
  - radio handset
  - MOVLAS control unit

  Feedback and Instructional Data:
  - Crosshair for optimum glideslope and MOVLAS positioning
  - Freeze indication
  - Approach results data ("MONITOR") - wire, hook to ramp distance, lineup on touchdown, sink rate on touchdown, aircraft roll angle on touchdown, aircraft pitch angle on touchdown
  - Approach dynamics plot ("SCORE") - pitch, fuel flow, lineup, sink rate, roll, AOA
  - Communications with instructor

  System Operation Functions (at student station):
  - LSO eye position adjustments
  - Crosshair selection
  - MOVLAS selection
  - Operate/reset for approach initiation
  - Selection and store/replay for canned approaches
  - Freeze selection
  - Aircraft engine and deck sound volume
  - Communications volume
  - LSO instrument console lighting intensity adjustment
  - Approach rerun and time segment selection
  - Horizon (peripheral) and stars intensity adjustments
  - Red and white lighting intensity selection

Instructor Station
  Situation and Performance Monitor:
  - Console CRT - LSO view, pilot view, crosshair display, pilot HUD, CCA positioning data
  - Student feature selection monitor - crosshair, MOVLAS, canned approach
  - Communications - LSO, pilot
  - Aircraft performance - aircraft instruments

  Situation Setup and Interaction:
  - Aircraft and pilot conditions
    aircraft lighting malfunctions (console)
    aircraft malfunctions (console)
    aircraft configuration variation (through pilot)
    planned deviations (through pilot)

TABLE 1. LSO REVERSE DISPLAY FEATURES (cont.)

- Environmental conditions
  deck motion (console)
  wind speed and direction (console)
  horizon definition (terminal)
  plane guard destroyer (terminal)
  ceiling and visibility (console)
  carrier deck selection (console and terminal)
- Landing aids
  FLOLS malfunction (console)
  MOVLAS (console)
  glideslope angle (terminal)
- Operational factors
  foul deck (console)
  low fuel state (console)
  pilot/LSO communications problems (console)
- Instructional functions:
  freeze (console)
  crosshair (console)
  canned approach (console)

Debrief:
- Rerun (console)
- Approach results data, "MONITOR" (console)
- Approach dynamics plots, "SCORE" (console)
- Crosshair (console)
- MOVLAS crosshair in rerun (console)
- X-Y plotter (console)
- Pilot PMS (terminal, line printer)

The instructor station at the NCLT console has several means for monitoring an LSO training session including an option for viewing either the LSO or pilot scene. For setup and control of a training situation, he has many options available, some controllable on the console, some through the computer system terminal and some through communicating with the pilot for planned approach deviations. Among his most significant instructional and debrief functions are freeze, approach rerun and control of data to be displayed to the trainee. For "pilotless" LSO training there are ten canned approaches available.

SECTION IV

ACTIVITIES

Several activities were involved in this study of the LSO Reverse Display (LSORD). The two major efforts were survey of LSOs familiar with the device and observation of training sessions which employed the device. From these two activities came most of the findings regarding the LSORD. Table 2 presents a listing of meetings and on-site visits which supported interaction with the LSO community. Other activities which were a part of this study included a literature review, development of syllabi for device utilization and the development of a long-term LSORD utilization data collection plan. Originally, a transfer of training study was planned. However, limited LSO availability and the resultant low LSORD utilization rate precluded such a study. Descriptions of study activities are provided below.

LITERATURE REVIEW

The literature review had two purposes. The first was to identify methods for conducting an evaluation of LSORD training effectiveness. The second was to identify and review literature relevant to the LSO job and LSO training. Two data bases were searched during this effort: National Technical Information Service (NTIS) and Psychological Abstracts. Key words and phrases used in this search included: Landing Signal Officer (LSO), Automated Training, Training Evaluation, Training System Evaluation and Training Transfer. Additionally, proceedings from the NAVTRAEQUIPCEN/Industry and Human Factors Society conferences also were reviewed. Results of the literature review provided guidance for all study activities, especially survey and observation. Literature reviewed is identified in the bibliography of this report. Additionally, Appendix A is an annotated bibliography of literature relating to the LSO.

SURVEY

Survey of the LSO community was directed toward LSOs who were familiar with the LSORD. Only a few LSOs surveyed had extensive experience in using the device for LSO training. The survey activity included distribution of a questionnaire as well as discussions and interviews with LSOs. Completed questionnaires were received from 20 LSOs, only three of whom had any significant experience with the LSORD. Most of the respondents were exposed briefly to the LSORD at an LSO conference. Discussion and interview occurred frequently throughout the study and was used to focus on specific features of the device, utilization techniques and syllabus considerations. The questionnaire results provided direction for investigation of specific aspects of the device during discussion and interview. Questionnaire results are described in detail in Appendix B. A copy of the questionnaire is presented in Appendix C.

Twenty questionnaires were completed by LSOs who had been exposed to the LSORD. Most were highly experienced LSOs, but only three had any significant experience working with the device. The device was rated very high for its overall potential value to LSO training (4.20 on a 1 - 5 scale), even though its ratings for simulation realism were rated only fair. The results also

TABLE 2. MEETINGS AND ON-SITE VISITS

Dates	Location	Purpose
July 79	NAS Lemoore	Familiarization with LSORD
August	NAS Lemoore	Project Kickoff Meeting; LSORD Familiarization
September	NAS Miramar	AIRPAC LSO Conference
October	NAS Cecil Field	AIRLANT LSO Conference; LSORD Data Collection
October	NAS Lemoore	Observation (Two visits)
November	NAS Miramar	Discussion of LSO Training
December	NAS Cecil Field	Observation
January 80	NAS Cecil Field	Interim Meeting
March	NAS Cecil Field	Observation, Discussion
April	NAS Lemoore	Observation, Discussion
May	NAS Corpus Christi, NAS Cecil Field	Observation, Syllabus Discussion

suggest that the device is very appropriate to Phase II, Phase III and refresher LSO training. Pitching deck, MOVLAS and "pickle time" were most frequently noted as valuable training capabilities. The most notable needs for improvement were perceptual quality of the simulation "in close" and "at the ramp". Ratings also were obtained for many candidate LSO performance measures. "Correctness and timeliness of LSO calls" had the highest rating (4.90 on a 1 - 5 scale).

OBSERVATION

On-site observation of LSO Reverse Display operation involved several visits to both NAS Lemoore and NAS Cecil Field. The first few visits were oriented to familiarization with the features and operation of the system. The remaining were oriented to observing specific operating characteristics and to observing system operation in a training context. At NAS Lemoore Phase II training was being conducted. Phase III training was being conducted during one visit to NAS Cecil Field. The trainees involved with the LSO Reverse Display had entry levels varying from very inexperienced, to Squadron qualification with night shipboard waving experience. All trainees were from the A7 community except one, who was from the S3 community. Two different LSO instructors were involved. One was from the A7 Fleet Readiness squadron, the other was an Air Wing LSO. Both instructors were very highly skilled LSOs and demonstrated a high degree of motivation and conscientiousness in their instructional duties.

The observation effort also included frequent interrogation of LSO instructors and trainees concerning their impressions of various features, instructor techniques, instructional strategies and conduct of training sessions. Information gathered during observation included frequency of feature utilization, opinions of feature effectiveness, instructor techniques used, procedures followed during training sessions, difficulties in system operation and instructor evaluation of trainee performance.

Early in the study, several potential discrepancies were identified with the visual simulation portion of the LSORD. As a result, increased attention was given to this part of the device in later observation activities. On one final visit to NAS Lemoore two specialists in visual perception, one of whom having extensive experience in visual simulation requirements, spent two days observing LSORD operation and discussing its perceptual characteristics with experienced LSOs. The results of their evaluation of the visual simulation are presented in Appendix D. Several aspects of the visual system which received attention included: occasional color separation (convergance), difficulties in judging lineup and glideslope "in close" and "at the ramp", fidelity of aircraft dynamics during scene rotation, and difficulties in judging nose attitude changes. The judgment of the evaluation team was that some apparent perceptual problems do exist, but they are not considered serious enough to raise doubts about the training effectiveness of the LSORD.

SYLLABUS DEVELOPMENT

Included in the requirements of this study was the development of syllabi to guide LSORD utilization in Phase II and Phase III LSO training. The

bases for these syllabi are the training requirements specified by the LSO Naval Air Training and Operating Procedures Standardization (NATOPS) Manual. Phase II training prepares the LSO trainee to conduct day and night Field Carrier Landing Practice (FCLP) operations for pilot training. Among the more difficult LSO skills in FCLP are MOVLAS utilization, LSO talkdown and pilot instruction. Phase III training focuses on carrier operations and prepares the trainee for Wing LSO designation. To attain this designation the trainee must demonstrate an ability to control a majority of air wing aircraft in day/night, all weather and deck conditions without assistance. Among the more difficult LSO skills in this phase are MOVLAS utilization, pitching deck conditions and aircraft malfunctions. Since the simulation capabilities of the LSORD are relevant to a significant portion of the LSO "waving" task, syllabi which supplement on-the-job training were developed. The development efforts and syllabus design rationale are described below.

The initial activity in Phase II syllabus development involved the identification of tasks associated with the conduct of FCLP. The task listing presented in Hooks and others (1978)[3], guided this effort. These tasks were then correlated to the syllabus design rationale and the syllabus from that report, as well as the Phase II training guidelines of LSO NATOPS. This provided a tentative sequencing of learning activities for the syllabus. The strategy of dividing the syllabus into two learning stages also evolved out of this process. Separate orientations of basic waving skills and pilot refresher training skills enables the trainee to acquire confidence in the perceptual and decision-making aspects of his performance prior to concentration on fine tuning his critique of pilot performance for instructional purposes. This strategy also emphasizes concentrated "hands on" waving experience in the initial stage of learning. A review of the Phase II syllabus, developed by LT Bullard of VA-122, and the information gathered from survey and observation activities, provided additional refinements to the sequence. It also guided the final syllabus mix of available media (FCLP, LSO Reverse Display, lecture). Thus, the recommended Phase II syllabus, Appendix E of this report, provides standardized guidance for learning activity sequencing and the integration of various media.

The initial activity in Phase III syllabus development involved the correlation of LSO carrier "waving" conditions to LSORD simulation capabilities. This, plus the task listing and syllabus sequencing rationale presented by Hooks and others (1978), were used to establish an initial sequence of topics for which the LSORD would support Phase III training. Survey data and information gathered during observation and discussion with LSOs help provide insight into specific LSORD strengths and limitations for Phase III training. From this data and from other studies[3,4,5], global syllabus implementation factors

3. J.T. Hooks, E.A. Butler, R.A. Gullen, R.J. Petersen, Design Study for an Auto-Adaptive LSO Training System, NAVTRAEQUIPCEN 77-C-0109-1, December 1978.

4. Borden, G.J., The Landing Signal Officer: A Problem Analysis, Vols. I, II, Technical Report 785-1, Human Factors Research, Inc., Goleta, Calif., May 1969.

5. Breaux, R., (Ed.), LSO Training R&D Seminar Proceedings, Technical Report IH-320, Naval Training Equipment Center, 1980.

were also identified. The results of these efforts were a series of training modules for mixing LSORD utilization with periods of shipboard on-the-job training (OJT). The primary emphases in LSORD utilization are MOVLAS, pitching deck, LSO talkdown and aircraft malfunctions/ emergencies. Additional LSORD features recommended for employment within the syllabus include WOD variations, NORDO, no horizon and reduced weather conditions. Features to be used for instructional control include freeze, crosshair, and rerun. The modular design of the syllabus allows flexibility of scheduling LSORD utilization within an environment of shipboard deployment variability and uncertainty. The recommended Phase III LSO training syllabus is presented in Appendix F of this report.

LSORD DATA COLLECTION PLAN

A transfer of training study was not accomplished during this project due to the extensive time required to track groups of trainees to the skill level required to wave aircraft at night aboard ship (approximately 1 - 2 years). Thus, since the findings of this study are based on a relatively small sample of LSO inputs, it was decided that a plan for collection of LSORD utilization data would be included in this report. Several factors entered into the development of this plan. The major consideration was the need to increase the responsiveness of the LSORD to actual LSO training needs. To accomplish this, data would be needed which reflects LSORD capability and utilization shortcomings, and recommendations for improvement. It also was desired that data be collected which could support a transfer of training study of the device. In order to aid in data collection efficiency, the plan was designed for implementation simplicity and minimum interference with normal LSO and trainee duties. The proposed data collection plan utilizes three tools: an LSORD utilization journal co-located with the device, a trainee grade sheet for LSORD training sessions, and a trainee progress report for performance aboard ship. The data collection effort is envisioned by the authors to cover at least a two-year period. Data analysis for training transfer from the LSORD to waving aboard ship would involve a comparison of fleet performance between trainees who have, and who have not, received LSORD training. Appendix G presents the recommended plan for collection of LSORD utilization data.

SECTION V

FINDINGS

This section presents the findings resulting from study activities. They are topically grouped to address the LSO Reverse Display, its features and utilization, and LSO training system concepts. The reader is reminded that the findings of this study are based upon inputs from a small sample of the Navy's LSO population. However, the LSOs who provided major inputs to this study possessed extensive LSO job and training experience. Additionally, one of the authors of this report served as a Navy LSO for over six years, attaining the highest LSO qualification level (Staff). Both of the authors have been involved in analytical studies of LSO task performance and training for the past three years. Thus, though the findings are limited from a scientific data basis, they do provide considerable insight into the strengths, limitations and potential training benefits of the LSORD.

THE LSO REVERSE DISPLAY

The LSO Reverse Display has demonstrated the potential to be a very effective training device for the A7 LSO community. As a minimum, simulation of the night carrier landing environment and an approaching A7 aircraft enables an LSO trainee to perform a considerable portion of the LSO waving task. Its most basic training benefit is to promote trainee "eye-mouth" coordination, or as expressed by a senior LSO: "...experience of holding a pickle in one hand, phone in the other and learning to talk." The highlights of the LSO Reverse Display are simulation of pitching deck conditions, provisions for LSO talk-down, and using the MOVLAS, three aspects of the LSO job which are inadequately addressed in the existing OJT program. Its capability for instructional control of carrier landing situations can provide training benefit to the naive LSO trainee as well as a trainee approaching Wing qualification. It also shows promise as an aid to refresher training for those returning from non-LSO tours of duty or from layoffs between deployments.

The LSO Reverse Display does, however, have some limitations of varying significance. One is its obvious orientation and convenient location to the A7 LSO community, thus limiting its impact on training for other LSOs. The requirement for a pilot in the NCLT has some potential impact on personnel support for LSO training. There are some perceptual difficulties for the trainee in the final portion of the approach.

The identified limitations do not override the benefits arising from integration of this device into LSO training. The key to its value is effective and conscientious utilization.

LSORD FEATURES. In the paragraphs below, findings regarding LSORD features are discussed. The order of discussion coincides with the listing of features provided earlier in Table 1.

Student Station. In general, the simulation capabilities provided in the LSORD are very adequate to support effective LSO training. Minor perceptual deficiencies were noted in the final portion of the approach. There are

difficulties encountered operating the device from the student station. Student station simulation and operation are discussed below in more detail.

The background carrier approach scene appears very adequate for training. A few LSOs suggested that the deck status lights should be more prominent. However, difficulty in monitoring these lights was considered an instructional benefit by others. It should help develop a good scan pattern for the trainee. Deck motion simulation was considered a particularly valuable training feature of the device. However, a few LSOs felt that deck trim should also be simulated. There were a few LSOs who strongly supported the display of the pilot view in the igloo to help the trainee correlate pilot and LSO perceptions early in LSO training.

The A7 visual simulation appears very adequate for training. However, there is an occasional convergence problem with aircraft lighting. The only significant criticism with any aspect of simulation was with perceived aircraft dynamics during the "in close" and "at the ramp" portion of an approach as discussed in Appendix D. LSOs felt that the aircraft looked higher and flatter at the ramp than actual approach results (wire) indicated. A few LSOs also felt that nose down pitch and lineup were difficult to perceive. Many LSOs felt that inclusion of more aircraft types in the simulation would greatly enhance its value to the LSO community.

There were surprisingly few criticisms of the LSO instrument console. The major negative comments related to absence of lens roll angle variability and waveoff light repeater. The training value of wind-over-deck (WOD) and hook-to-ramp indicators was confirmed. A few LSOs felt that the console should include a Pilot Landing Aid Television (PLAT) repeater. However, more experienced LSOs felt that absence of the PLAT provided more effective training emphasis on lineup perception.

The audio simulation for an approaching aircraft was considered very adequate. There were criticisms of background deck noise realism, but no one felt that it affected training effectiveness. In fact, for early training the deck noise is usually turned off.

The use of actual LSO controls (radio, pickle, MOVLAS) in the igloo was considered very effective for training. Provisions for MOVLAS waving was considered a particularly valuable training feature.

Freeze and replay were considered excellent instructional features. In conjunction with glideslope crosshair (green) they effectively support instructor feedback and also allow self-critique by the trainee. However, trainee selection of the glideslope crosshair requires some "fumbling" with the LSORD control box and its cover in the igloo. The MOVLAS positioning crosshair (red) is also a valuable feedback tool.

At the end of an approach, data ("MONITOR") available, at instructor option, concerning landing dynamics has some feedback value. Hook-to-ramp distance, lineup and sink rate appear useful but the "MONITOR" display is excessively bright. Rerun plots ("SCORE") of pitch and fuel flow are also useful on occasion to help the LSO trainee learn to analyze pilot errors. The

communications between trainee and instructor are occasionally garbled. This may be due to acoustic deficiencies in igloo design. However, it is not considered a significant problem.

In terms of student station operation there were several items worthy of note. It is extremely difficult for two individuals to view an approach simultaneously because of a very restrictive viewing volume. This hampers over-the-shoulder instruction and LSO team training, neither of which were considered significant in limiting training effectiveness. Access to system operating controls is slightly difficult. The primary one of interest is the glideslope crosshair control. However, its access has been improved at the Lemoore site. The cover for the operating controls must be kept closed to prevent glare in the CRT optics from the brightly lit push-tile switches. Access to igloo illumination controls near the door is also difficult. A deficiency in the NAS Cecil Field installation is that there is no ceiling mounted red floodlight. It is shielded over the entry way.

Instructor Station. In general, the instructor station provides adequate control and trainee monitoring capabilities. The only significant criticisms concern limited control over some situation variables and difficulty in monitoring trainee waveoff and MOVLAS actions. Instructor station features are discussed below in more detail.

The instructor can monitor trainee performance through a CRT repeater of the LSO or pilot view, crosshair display, voice communications from trainee to pilot and aircraft instrument indications. He cannot monitor the trainee's MOVLAS positioning unless he switches back and forth between pilot and LSO view, or observes the pilot view on the CRT in conjunction with the X-Y plotter depiction of glideslope. He cannot see when the trainee activates his waveoff lights unless he is observing the pilot view. For the instructor to ensure that the trainee's crosshair is not selected, he must deselect his own crosshair.

The instructor can select limited aircraft lighting malfunctions (wing lights on/off, AOA lights on/off). He cannot selectively freeze or extinguish specific AOA lights (for fast, slow, on-speed). Through the NCLT pilot, the instructor can covertly request planned approach profiles and deviations. However, several attempts are usually required to achieve the desired situation. Horizon variations and plane guard destroyer selection require slight session delays since their control is through the computer terminal.

Inability to selectively manipulate lens roll angle for LSO scan training was considered a significant shortcoming in the LSORD. Inability to manipulate ship trim was also considered a noteworthy shortcoming.

Shortage of canned approaches was also considered a major deficiency of the LSORD. Ten canned approaches are not sufficient to show the trainee the variety of critical approach profiles and situations needed in early training. They are also insufficient to provide meaningful "instructorless" training for the highly motivated trainee who desires additional exposure.

Freeze, replay, glideslope crosshair, and MOVLAS positioning crosshair provide excellent instructor control of feedback and debrief to the trainee. Inability of the instructor to select glideslope crosshair for the trainee was the only negative item noted.

LSORD UTILIZATION. The LSO Reverse Display appears to have the capability to support many levels of LSO training, some levels more significantly than others. If effectively employed, it should decrease calendar time required for LSO skill acquisition and provide significantly more "hands on" experience with more portions of the LSO task than are currently available in OJT. A very experienced Air Wing LSO expressed the opinion that the LSORD "... will undoubtedly pay for itself many times over in averted hard landings, bingos and other damage or loss caused by poor LSO technique."

Even though the LSORD simulates only the A7, it should provide very effective training to LSOs from other communities. Since all air wings have A7 squadrons, trainees must eventually learn to wave the A7. Most importantly is the fact that basic waving skills do not differ from one aircraft to another. Therefore, skills required in the LSORD should be very transferable to other aircraft. Adequate LSO access is a far more important consideration in LSORD effectiveness. The recent relocation of the LSO Phase I school staff to NAS Cecil Field has the potential to provide personnel support, utilization encouragement and continuity of LSORD training management to fleet LSO users (Phase II and III LSO training). Subsequent paragraphs discuss the role of the LSORD in various levels of LSO training and the potential limitations on its effectiveness.

<u>Phase I LSO Training</u>. As a part of the LSO Phase I School curriculum, the LSO Reverse Display could provide instructionally controlled familiarization with the night carrier landing environment and "hands on" familiarization with the waving task. The recent relocation of the LSO Phase I school to NAS Cecil Field makes this a very practical possibility. Use of the LSORD in the curriculum can reduce school dependency on FCLP and carrier operations schedules to expose the trainee to waving.

<u>Phase II LSO Training</u>. One of the prime assets of the LSORD in support of LSO training is the provision for safe, "hands on" waving experience at the outset of Phase II training. Another prime asset is the instructional control available through such features as freeze, rerun and crosshair. Of the situational features available, MOVLAS and LSO talkdown conditions are particularly appropriate to Phase II training. An effective syllabus can employ these and other features of the device, in conjunction with the FCLP environment, to guide the trainee through the completion of Phase II training. It can help promote incremental acquisition of field qualification skills in two stages of orientation, waving and pilot training. Adaptive instructional control, based on learner differences in acquiring LSO skills, can be implemented by the instructor using the LSORD for: remedial training sessions, additonal practice and accelerated introduction of new topics during training sessions. It is expected that trainee performance and learning rate while in the LSORD will be significantly enhanced if he has observed night operations aboard ship. Effective utilization of the LSORD in Phase II training should produce a

field-qualified trainee who is much better prepared for Phase III than was ever possible before.

One very experienced Air Wing LSO, who has worked extensively with the LSORD, suggested that Phase II training is where the trainee should learn the "hard lessons" of carrier waving. He pointed out one very interesting technique for teaching a "hard lesson": "I can hit the ramp when the LSO (trainee) isn't expecting it." This implies an interesting re-orientation of Phase II LSO training to include many aspects now considered a part of Phase III training, such as pitching deck, aircraft emergencies and poor weather conditions.

Phase III LSO Training. The LSORD appears best suited to support Phase III training because of its simulation of a considerable portion of the night carrier landing environment. As discussed earlier, the features of the device permit an instructor to manipulate the learning experience of the trainee to focus on specific instructional objectives and to provide remediation and practice. Extensive use of the device between CQ and deployment work-up periods looks like the best timing of the device in Phase III. This device provides an Air Wing LSO with a tool for increasing the "pickle time" for his trainees and for additional opportunities to evaluate trainee skill acquisition progress. The increased waving experience available through the LSORD should accelerate skill acquisition. "Hands on" experience with pitching deck, MOVLAS, LSO talkdown and aircraft emergency situations should produce a more highly skilled Wing qualification LSO than is now possible in the existing climate of reduced carrier operations. Although many aspects of the carrier operating environment can be addressed with the LSORD, the primary payoff potential appears to be related to emphasis on pitching deck and MOVLAS.

Proficiency and Refresher LSO Training. The simulation fidelity appears adequate to support limited maintenance of skill proficiency during extended time periods between deployments and refresher training for LSOs returning from non-LSO tours of duty. However, most LSOs suggested that only minimal training in the LSORD would be required to get an experienced LSO "up to speed."

Potential Limitations to LSO Reverse Display Effectiveness. Several factors could limit effectiveness of the LSO Reverse Display in LSO training. Most are not unique to the LSO Reverse Display. A shortage of instructor LSOs can significantly reduce device utilization and effectiveness. Heavy loading of pilot training in the NCLT can limit availability of LSO Reverse Display training time. Limitations in trainee availability for LSO training due to flying duties, school attendance, other job responsibilities, etc., is also a factor. Negative attitudes of instructor, trainee and supervisory personnel toward the LSO Reverse Display can impact its utilization rate and negate its effectiveness. Inattention to quality control of the training syllabus can cause degradation of LSO Reverse Display training effectiveness.

LSO TRAINING SYSTEM CONCEPTS

Evaluation of the LSORD has provided an opportunity to indirectly assess some of the LSO training system functional concepts recommended by Hooks and

others (1978).[6] Based on the promise demonstrated by the LSORD, the authors and the experienced LSOs involved in this study are particularly confident that the LSO training program can benefit from trainee task interaction in a simulated waving environment under the cognizance of an instructor LSO.

Interaction with LSO during this study support previous estimates that only night carrier recovery conditions are required in simulated LSO training. During night shipboard operations is when "pickle time" for a trainee is at a premium. The most difficult and critical waving situations usually occur in night operations. The author concurred with LSO inputs that capabilities to simulate pitching deck conditions, MOVLAS utilization, LSO talkdown and aircraft emergency situations have the highest payoff in preparing a trainee for Wing LSO qualifications. These are conditions under which a trainee typically does not get "pickle time" in the fleet. Based on training and demonstrated proficiency with these situations in an LSO training system, the supervisory LSO is more likely to allow a trainee to wave in these circumstances, thus enhancing the benefits derived in OJT.

The potential non-availability of NCLT pilots noted in this study and the need for an instructor to present approach profiles for specific training objectives supports the notion of some means for independent control of aircraft dynamics. Instructor station "joystick" control of the aircraft and its response to trainee actions appears to be a promising feature for a stand-alone LSO training system. Computer control of aircraft dynamics and pilot response to the LSO using automated speech recognition is another possibility. However, no conclusions can be drawn regarding the cost-effectiveness of such a feature.

The type of visual system in the LSORD appears to be a leading candidate for future LSO training systems. Its cost is relatively low in comparison to wide angle projection systems and its performance seems adequate. The perceptual shortcomings identified in this study appear resolvable.

Subjective instructor evaluation of trainee performance and instructor decisions on feedback and syllabus control appeared very effective in LSORD training. In early sessions for a trainee, evaluation appears primarily based on pass recall and descriptive commentary, two aspects not amenable to "instructorless" evaluation. Uncertainty still remains concerning the feasibility and effectiveness of automated performance evaluation based on "correctness and timeliness of voice calls." However, an interesting possibility is automated evaluation in selected critical waving situations for which performance criteria could be well defined.

No firm conclusions could be drawn regarding the concept of automated LSO training, encompassing aircraft/pilot/LSO interaction, performance evaluation, instructional feedback and adaptive syllabus control worthy of continued research in view of the shortages of skilled LSO, which continues to plague the Navy.

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6. J.T. Hooks, E.A. Butler, R.A. Gullen, R.J. Petersen, Design Study for an Auto-Adaptive LSO Trainnig System, NAVTRAEQUIPCEN 77-C-010901, December, 1978.

SECTION VI

RECOMMENDATIONS

Several recommendations are presented as a result of this evaluation of the LSO Reverse Display. The most important is that the LSO community should significantly increase utilization of the device in support of LSO training. For increased effectiveness, several specific improvements are also recommended.

THE LSO REVERSE DISPLAY

The findings of this study support several recommendations regarding improvements in LSORD features and capabilities. They also support recommendations regarding effective utilization of the LSORD in support of LSO training. Specific LSORD recommendations are presented below.

LSORD UTILIZATION. As mentioned earlier, one of the strongest recommendations resulting from this study is that LSORD utilization should be increased significantly if its benefits are to be realized. Additionally, use of the LSORD should be closely monitored to improve utilization effectiveness and to determine additional needs for device enhancement. Specific recommendations are described below.

LSORD Support to LSO Training. The primary role of the LSORD should be in support of Phase II and Phase III training. It is recommended that the syllabi included in this report receive timely review by the LSO community for possible modification and for timely implementation into the training programs conducted by Air Wing LSOs. It is recommended that the LSO Training Model Manager and the LSO School staff at NAS Cecil Field provide LSORD familiarization and training guidance to Air Wing LSOs to help them effectively utilize the device. The LSO Training Model Manager should have at NAS Lemoore a qualified LSO as a designated LSORD coordinator to provide similar support to Air Wing LSOs on the west coast. It is recommended that this individual be assigned to the functional wing at NAS Lemoore. If feasible, type commander LSOs should establish a policy which requires use of the LSORD as an integral part of LSO training. As a minimum, LSO talkdown, pitching deck and MOVLAS instruction in the LSORD should be required as a part of Phase III LSO training.

The effective use of the LSORD in the Phase I school should be explored. As a start in this area, it is recommended that each Phase I school student receive an LSORD familiarization session and two brief sessions of observing approaches and with some introductory waving. The type commander LSOs should explore the effectiveness of using the LSORD for refresher LSO training and for preparation of LSOs for Air Wing billets.

It is recommended that an instructor manual and student guide be developed to support standardized LSORD training utilization. Current LSORD documentation is inadequate to effectively aid the potential LSORD instructor. The instructor manual should provide clear descriptions of LSORD features and their use as well as syllabus implementation guidance. The student guide

should describe the LSORD and instructional objectives, and should provide guidance for session preparation, limited self-training and recommended reference materials. These documents should be periodically updated based upon ongoing user evaluation of the LSORD and its syllabus.

Feature Utilization. To discuss recommendations regarding LSO Reverse Display feature utilization in training, an operational context is provided. The commentary below "walks" through a training session, identifying instructional techniques and procedures which are potentially effective. These were derived by the authors based on observation of LSO training in the LSORD and on discussions with experienced instructor LSOs. An experienced instructor LSO would be required for effective employment of these guidelines.

a. General: Two or three trainees can be employed for each scheduled period, performing different roles on a rotational basis during the period: one in the NCLT, one in the "igloo," and the third with the instructor at the console.

The optimum time in the igloo for a trainee appears to be 30 to 40 minutes; 5 minutes of that is needed for dark adaptation and environmental acclimation. Optimum instructor positioning is at console except for familiarization sessions and for initial MOVLAS training.

b. Briefing: The trainees should be briefed on the purpose of the training session, trainee actions (calls, grading, etc.), situations to be encountered, and relevant "igloo" controls (crosshair, MOVLAS, etc.).

c. Session conduct: For warm-up, the trainee should initially observe and/or wave several approaches, with rerun and crosshair used frequently to aid acclimation. Canned approaches may be useful for this. Instructor then presents approaches and situations for the training specified by the syllabus. Approaches should start about 1 to 1-1/2 miles out. Trainee points out deviations, waves, grades, etc., as appropriate. Instructor also mixes previously learned situations into session. If appropriate, third trainee or instructor acts as book writer at console for trainee in igloo. After trainee has been introduced to the waveoff, ensure the presentation of several waveoff situations during each session. Direction to the NCLT pilot to provide specific deviations is usually effective, but it frequently requires multiple attempts for success.

d. Instructional actions: During early portions of syllabus, instructor should frequently freeze the approach on trainee errors. Also, in early portions of syllabus two reruns of an approach appear effective; in later portions of syllabus only limited use of rerun may be necessary. Crosshair utilization should also become less and less necessary as the trainee's basic perceptual skills increase. For approaches when trainee has difficulty detecting power or pitch deviations, use of the "SCORE" plots in rerun, followed by an uncluttered rerun should be useful. Frequent instructor feedback and informational commentary should be used throughout training (after almost every approach) since there are no clear, objective criteria established for trainee performance.

e. Debriefing trainee: There are several areas appropriate to end of session debrief. Commentary is needed regarding the trainee's perception of glideslope, lineup, and AOA deviations and pilot corrective actions. Commentary is also needed regarding the correctness and timeliness of trainee voice calls. Specific attention should be given to the trainee's performance in waveoff situations. During the debrief the commentary should be oriented to trainee trends in the above areas. Debriefing should be on both a group and individual basis.

f. Trainee performance tracking: A "grade" sheet should be utilized to account for trainee performance quality in each session and to track the trainee's experience with various learning situations, such as MOVLAS, LSO talkdown, etc. This record keeping can also support a syllabus quality control effort.

Continued LSORD Evaluation. In view of the limited LSORD utilization on which study results are based, it is strongly recommended that utilization of the LSORD be closely monitored and evaluated over the next two years. This should be the responsibility of the LSO Training Model Manager. Appendix G provides a recommended plan for collection of LSORD utilization data to support this effort. Data from the utilization journal, LSORD grade sheets and trainee progress reports should be used to identify needed changes to the LSORD and its training syllabus and to determine the transferability of LSORD training to the fleet waving environment.

LSORD FEATURES. Recommended improvements to the LSORD have been organized into two groupings. The highest priority items are expected to have a significant positive impact on LSORD training effectiveness. These recommendations include (listed in descending order of importance):

a. increase the number of canned approaches available,

b. add a pilot intervention capability for the canned approach mode,

c. add an indication of trainee activation of waveoff lights at the instructor console,

d. add the presentation of the MOVLAS crosshair at the instructor console during an original approach,

e. incorporate instructor capability to manipulate FLOLS roll angle,

f. incorporate capability to simulate carrier out of trim condition.

The number of canned approaches should be increased to approximately fifty (50) in order to provide efficient instructional presentation of important approach profiles and waving situations. Many of these will be useful in teaching basic perceptual skills needed for trainee recognition of glideslope, lineup and AOA deviations. Others will be used for introduction to many of the variables involved with waving night carrier approaches such as pitching deck, aircraft lighting malfunctions and weather extremes. Of primary importance will be the use of canned approaches to expose the trainee to typical

approach profiles and pilot error trends which can lead to unsuccessful landings (bolters, ramp strikes, hard landings).

The canned approach mode of the LSORD, as it currently exists, precludes LSO task interaction. Adding a capability enabling a pilot in the NCLT to take control of the aircraft during a canned approach would allow LSO trainee task interaction in standardized, learning objective-based approach situations. It is estimated that this feature would enhance trainee skill acquisition, improve training session efficiency, and reduce instructor workload.

The instructor needs an indicator of trainee waveoff light activation in order to effectively monitor trainee performance in critical waveoff situations. Proper timing of waveoff light activation is an extremely important skill which currently cannot be evaluated effectively by the instructor from his console.

Currently, the MOVLAS crosshair is not available during the original "flying" of an approach. Instructor evaluation of trainee MOVLAS performance is therefore delayed until replay of the approach. This precludes the instructor from providing immediate feedback to the trainee and adds extra time to the MOVLAS instructional process since at least one approach replay is always required for performance evaluation.

Scan of FLOLS roll angle setting prior to an approach is an important LSO habit pattern element. An improper setting causes an incorrect display of glideslope cues to the pilot and can result in an unsafe hook-to-ramp clearance for the aircraft. It can also be an indirect cue to the LSO that the arresting gear may be set for the incorrect type of aircraft, a situation which can result in aircraft or arresting gear damage upon landing. Control over the roll angle can enable an instructor to provide training emphasis on this important aspect of the LSO waving task.

Frequently, an aircraft carrier operates in an out-of-trim condition. Pitch trim variances change the hook-to-ramp clearances of the aircraft and list (roll trim variance) affects LSO and pilot perception of lineup in the final portion of an approach. In order to effectively prepare a trainee for this situation variable, instructor control of deck trim is recommended.

The other group of LSORD feature recommendations are considered less important than those discussed above. However, the authors estimate that they could have a positive impact on LSORD training effectiveness for the reasons stated in subsequent paragraphs. These recommendations include (listed in descending order of importance):

a. technical investigation of scene rotation to improve flight dynamics fidelity from "in close" to touchdown,

b. technical investigation of color convergence to improve long term stability,

c. instructor control of trainee crosshair selection,

d. simulation of additional types of aircraft,

e. presentation of pilot view at the student station,

f. incorporate "joystick" control of aircraft dynamics at instructor console.

Perceived flight dynamics fidelity discrepancies can affect trainee learning associated with the terminal aspects of an approach. He may not be learning to correctly recognize pilot deviations at the ramp and the terminal effects of these deviations. For an experienced trainee or a qualified LSO, this problem may cause perceptual confusion and reduced training credibility for the device. It is recommended that scene rotation timing be manipulated to determine whether improvement can be achieved.

Color convergence problems cause incorrect AOA light cueing and visual distractions in other lights within the approach scene. Improving color convergence stability would alleviate these problems. It is recommended that a technical investigation of the color convergence problem be initiated.

As mentioned earlier, trainee selection of glideslope crosshair is a difficult task. Providing instructor control of this feature should improve training session efficiency.

It is recommended that a few additional types of aircraft be incorporated into the visual simulation. This should provide an increase in transfer of training from the LSORD to the actual carrier operating environment in terms of aircraft visual and flight dynamics characteristics. It would also allow increased coverage in the LSORD of the requirements for Phase III LSO training.

Presentation of the pilot view at the LSO training station could prove useful in helping a new trainee to relate basic LSO perceptual skills to his pilot skills. It can also provide an added perspective in the assessment of pilot errors and trends.

Incorporation of "joystick" control of aircraft dynamics can reduce dependency on NCLT pilots for LSO training. It can also give the instructor greater control in presenting desired approach profiles and pilot errors. It is recommended that the aircraft fly optimum glideslope, lineup and AOA until "driven" to a deviation by the instructor. This will minimize the task loading of the instructor in using this feature.

LSO TRAINING SYSTEM CONCEPTS

It is recommended that NAVTRAEQUIPCEN continue monitoring LSORD utilization as a part of ongoing research into LSO training system requirements. It is also recommended that NAVTRAEQUIPCEN investigate the possibility of automating the LSORD at NAS Cecil Field as a prototype LSO training system option. Although not an optimum research tool, it is worthy of attention as a potentially low cost alternative to a "from scratch" prototype procurement. The

add-on features needed for this option would include the high priority feature recommendations described earlier, plus:

a. "joystick" and computer control of aircraft flight dynamics,

b. automated speech recognition,

c. LSO performance data collection (voice calls and control activations correlated to aircraft dynamics, as well as manual instructor grading inputs),

d. collection of data reflecting instructor actions during training sessions.

It is also recommended that the Navy evaluate the feasibility of adding LSO training stations to night carrier landing trainers in other aircraft communities to increase LSO training support outside the A7 community.

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ACRONYMS

AIRLANT	Naval Air Forces Atlantic
AIRPAC	Naval Air Forces Pacific
AOA	Angle of Attack
APC	Automatic Power Compensation
CCA	Carrier Controlled Approach
CQ	Carrier Qualification
CRT	Cathode Ray Tube
CV	Aircraft Carrier
DLC	Direct Lift Control
FCLP	Field Carrier Landing Practice
FLOLS	Fresnel Lens Optical Landing System
HUD	Head Up Display
LSO	Landing Signal Officer
LSORD	LSO Reverse Display
MOVLAS	Manually Operated Visual Landing Aid System
NAS	Naval Air Station
NATOPS	Naval Air Training and Operating Procedures Standardization
NCLT	Night Carrier Landing Trainer
NORDO	No Radio
OJT	On-the-Job Training
PLAT	Pilot Landing Aid Television
PMS	Performance Measurement System
FRS	Fleet Readiness Training Squadron
TRACOM	Naval Air Training Command
WOD	Wind Over Deck

APPENDIX A

ANNOTATED BIBLIOGRAPHY ON LSO

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A situation is described in which a pilot has significant difficulty landing aboard ship during CQ which leads to a confrontation between the LSO and squadron commanding officer. There are also some valuable editorial comments.

2. Borden, G.J., The Landing Signal Officer: A Problem Analysis, Vols. I, II. Technical Report 785-1, Goleta, Calif.: Human Factors Research, Inc., May 1969.

Volume I of this report provides a detailed description of the LSO's job and his role in the carrier landing process. It also identifies various problems encountered by the LSO in performing his tasks and in his career pattern, and suggests several problem solutions. The results of this study were based on a comprehensive survey of the LSO community with responses from about one-half of all Navy LSOs. Volume II of the report provides the detailed descriptive statistics for the data collected in the study.

3. Borden, G.J., The Landing Signal Officer: Display Requirements for ACLS Recoveries, Goleta, Calif.: Human Factors Research, Inc., 1972.

This report describes an effort to determine the information requirements of LSOs to effectively control Automatic Carrier Landing System (ACLS) recoveries. It describes the LSO's role in the ACLS recovery environment, and an experimental study to evaluate several LSO information display options.

4. Borden, G.J., The Landing Signal Officer: Work Station Design. Technical Report 1707, Human Factors Research, Inc., 1970.

This report describes design recommendations for an improved LSO workstation. Also included are descriptions of LSO information requirements and how LSOs use information to help control aircraft recoveries. The information in this report was eventually used in the development of an LSO HUD.

5. Borden, G.J., McCauley, M.E., Computer-Based Landing Signal Officer Carrier Aircraft Recovery Model, Progress Report, Goleta, Calif.: Human Performance Research, Inc., 1978.

The first phase of a government-contracted effort to model LSO waving behavior is described in this report. A preliminary model of LSO decisions and output actions is presented which was based on extensive interviews and discussion with experienced LSOs.

6. Breaux, R., (Ed.), LSO Training R&D Seminar Proceedings, Technical Report IH-320, Naval Training Equipment Center, 1980.

This publication is an accumulation of papers presented at a seminar to review Naval Training Equipment Center efforts toward designing a universal LSO training system. Papers were presented by government civilian and military personnel, and by civilian contractors. Among the papers presented are descriptions of LSO R&D contract efforts.

7. Brictson, C.A., Evaluation of the Special Senses for Flying Duties: Perceptual Abilities of Landing Signal Officers (LSOs), La Jolla, Calif.: Dunlap and Associates, Inc., 1974.

This paper discusses the perceptual skills of LSOs and an experiment to help develop a perceptual ability test battery for LSO selection and training. Several perceptual ability tests are described. LSOs scored higher in most perceptual ability tests than normative groups and higher than pilots on several tests.

8. Chatfield, D.C., Marshall, P.H., and Gidcumb, C.F., Instructor Model Characteristics for Automated Speech Technology (IMCAST), Technical Report, NAVTRAEQUIPCEN 79-C-0085-1, Naval Training Equipment Center, 1979.

This report describes a study to investigate the application of basic research in cognitive processing to instructor function models for training systems employing automated speech technology. Portions of the report are devoted to instructor modeling concepts for an automated LSO training system. Two other jobs, GCA controller and Air Intercept Controller are also discussed.

9. Durand, T.S. and Wasicko, R.J., Factors Influencing Glide Path Control in Carrier Landing, Journal of Aircraft, 4, Systems Technology, Inc., 1967, 146-158.

This article describes the geometry and dynamics within the carrier landing "system" which encompasses many elements such as the aircraft, LSO, pilot, FLOLS carrier and environmental factors. A significant discussion is devoted to carrier deck motion, FLOLS stabilization and the concept of Compensated-Meatball Stabilization (CMS).

10. Erickson, D.P., Landing Signal Officer Guide and Training Plan, circa 1978.

This document is a comprehensive accumulation of reference materials to support most aspects of the LSO job. It provides technical descriptions of various equipments used in shipboard launch and recovery and the geometries associated with landing aids and operating conditions. It also provides training guidance to help the Air Wing LSO conduct an effective OJT program.

11. Flatley, James H., The LSO - Forever an Asset, Approach, Naval Safety Center, 1974.

This article provides interesting historical perspectives on the LSO job, LSO training and carrier landing accident rates since 1959. The career patterns of LSOs and career enhancement aspects of being an LSO are also described.

12. Hooks, J.T., Butler, E.A., Gullen, R.A. and Petersen, R.J., Design Study for an Auto-Adaptive Landing Signal Officer (LSO) Training System, Technical Report, NAVTRAEQUIPCEN 77-C-0109-1, Naval Training Equipment Center, 1978.

This report describes a government-contracted effort to provide preliminary design guidance for an automated universal LSO training system. Included are descriptions of the LSO job, the LSO training program, candidate LSO training system functions and a tentative syllabus for system utilization. It also includes an assessment of relevant training technology and a design for a laboratory LSO training system.

13. Hooks, J.T., Butler, E.A., Reiss, M.J. and Petersen, R.J., Landing Signal Officer (LSO) Laboratory System Software, Technical Report, NAVTRAEQUIPCEN 78-C-0151-1, Naval Training Equipment, (in press).

This report describes the government-contracted development, capabilities and experimental utilization of a laboratory LSO training system. Also included are recommendations for the functional characteristics of an automated experimental prototype LSO training system.

14. Lacy, J.W. and Meshier, C.W., Development of a Landing Signal Officer Trainer, Proceedings, First Interservice/Industry Training Equipment Conference, Technical Report, NAVTRAEQUIPCEN IH-316, Naval Training Equipment Center, 1979, 79-90.

This paper describes the efforts involved in the development of an LSO training station for the A7E Night Carrier Landing Trainer, commonly called the LSO Reverse Display. A chronology of development activities and a brief description of the device are presented.

15. Mears, Mike, MOVLAS Techniques for Pilots and LSOs, Approach, Naval Safety Center, 1976.

This article discusses MOVLAS waving techniques and the need for LSO and pilot practice with MOVLAS recoveries aboard ship. Several important MOVLAS utilization considerations are presented as well as specific guidance to LSOs and pilots for successful MOVLAS approaches.

16. Mitchell, C.S., The LSO Head-up Display, Approach, Naval Safety Center, 1975.

Article presents a brief description of the prototype LSO HUD and its initial testing.

17. Nave, Ronald L., A Pilot/LSO Simulation Conducted to Investigate Aircraft Waveoff Performance and to Determine the Ability of the Landing Signal Officer to Judge Aircraft Approaches, Naval Air Development Center, Warminster, Pa., 1974.

This reports a government simulation effort to investigate aircraft waveoffs and LSO perceptual abilities. A manned simulation, the two-domed ACM simulator at the Naval Air Development Center, was used in this study. The results presented include recommended minimum design requirements for some aircraft characteristics and estimates of LSO ability to judge several approach parameters.

18. Reigle, M.E. and Smith, R.H., Preliminary Study of Optimal Waveoff Control: A Parametric Approach, Naval Air Development Center, NADC-72079-VT, 1973.

This report describes a government effort to investigate optimum piloting techniques for waveoff execution. This was approached through the application of a concept called optimal control doctrine in computer simulation. There is only minimal reference to the LSO.

19. Saunders, G.J., LSO - The Forgotten Man, Approach, Naval Safety Center, 1977.

This article identifies many problems associated with the LSO job and LSO training. The author's emphasis is upon long-term neglect of the LSO by higher authority. Several potentially beneficial problem solutions are also discussed.

20. Smith, R.H., LSO-Pilot Interviews on Carrier Approach, Naval Air Development Center, VT-TM-1681, 1973.

This report presents interviews with LSOs and pilots regarding carrier approach and landing dynamics and interactions. To the experienced LSO, some of the questions may appear naive and the credibility of some of the LSO respondents may appear questionable. The results do point out the individuality of styles among pilots and LSOs.

21. Smith, R.H., The Landing Signal Officer: A Preliminary Dynamic Model for Analyses of System Dynamics. Naval Air Development Center, NADC72078-VT, Warminster, Pa., 1973.

This report describes a digital computer model for LSO task dynamics. The rationale for various aspects of the model, as well as modelling assumptions and limitations are discussed.

22. Stueck, Phillip Gary, LSO Pilot Interaction Simulator, Naval Postgraduate School, Monterey, California, June, 1973.

This is a thesis which describes a manned pilot/LSO interaction simulation which was developed at the Naval Postgraduate School.

23. U.S. Navy, Carrier Aircraft Recovery Simulator (CARS) proposal letter, VAQ-129 NAS Whidbey Island, Washington, May 26, 1976.

This letter is an Operational Requirements (OR) proposal for the characteristics needed in a training device to support the LSO training program. It also includes information to support the operational need for the device as well as describing the problem leading to the need.

24. U.S. Navy, Office of the Chief of Naval Operations. The Naval Air Training and Operating Procedures Standardization (NATOPS) Program Manual, C.V., Department of the Navy, 1975.

This manual, commonly called CV NATOPS, provides policy guidance for carrier operations. Included are procedures for control of shipboard aircraft during flight deck operations and during launch and recovery. Responsibilities of the LSO and other shipboard personnel are described.

25. U.S. Navy, Office of the Chief of Naval Operations, The Naval Air Training and Operating Procedures Standardization (NATOPS) Program Manual, Landing Signal Officer (LSO NATOPS), Department of the Navy, 1975.

This manual, commonly called LSO NATOPS, provides policy guidance for the LSO job. Included are procedures for FCLP and carrier operations and emergency situations; descriptions of LSO training phases, qualification levels and job responsibilities; and procedures for record-keeping and reporting. A Phase I LSO training syllabus is also included.

26. Vought Corporation, Proposal for Development of an A-7E NCLT Landing Signal Officer (LSO) Training Station, May 1977 (with revision R1 of July 1977 and R2 of September 1977).

This document describes proposed capabilities of an LSO training station, now called the LSO Reverse Display, for the A7E Night Carrier Landing Trainer. Included are technical descriptions and diagrams of functions and equipment. Some of the capabilities and functions described in this document were eventually modified when the device was actually developed. Thus it is only a partially accurate reference. However, until the 2F103 documentation is updated by Vought, it remains the only known technical reference for the LSORD.

27. Webb, G.J., LSOs - An Endangered Species, Approach, Naval Safety Center, 1975.

The author presents a comparison of typical LSO and trainee experience in carrier landing operations before 1973 and after 1973. His data estimates indicate that the LSO trainee waves approximately half as many passes in a "post-'73" sea duty tour than he did in a "pre-'73" tour. He takes a gloomy view of the numbers and skill levels of qualified LSOs in coming years.

28. Webb, G.J. The In-close Waveoff, Approach, Naval Safety Center, 1976.

The author presents strong opinions regarding required pilot techniques for "in-close" waveoffs. He also discusses several factors which must be considered by the LSO in making the "in-close" waveoff decision. Immediately following this article the viewpoints of several other LSOs are also presented.

APPENDIX B

QUESTIONNAIRE RESULTS

SURVEY SAMPLE

The questionnaire entitled "Evaluation of LSC Reverse Display" was distributed to 35 LSOs, primarily of the A-7 community. A copy of the questionnaire is included as Appendix C.

Completed questionnaires were received from 20 LSOs. Of the 20 respondents, 19 identified themselves and provided demographic data. One chose to remain anonymous. The LSOs who provided demographic data included 5 LTJGs, 6 LTs and 5 LCDRs. Seven of the LSOs had previous experience with the Night Carrier Landing Trainer (NCLT), while 12 had none. Only 3 of the LSOs had previous experience with the LSORD portion of the NCLT. Therefore, 16 (and possibly 17) of the 20 LSOs were responding to the questionnaire based on limited experience with the Reverse Display.

While the LSO sample was limited in prior exposure to the Reverse Display, nearly all had extensive LSO and pilot experience. Six were Staff-qualified LSOs, 3 were Training-qualified, 4 were Wing-qualified, 4 were Squadron-qualified, and 2 were field-qualified. Years of experience as an LSO ranged from 1 to 11 in the sample, with a median of 5 years.

The median number of carrier landings was 220 day and 80 night. Four LSOs in the sample had over 150 night landings. The A-7 was the primary aircraft for 9 of the LSOs, the A-6 for 4, the F-4 for 2, and the remaining 3 LSOs flew the A-3, S-3, and E-2, respectively.

LSORD FEATURES RATING

The LSOs were asked to rate some of the training features of the LSORD, as well as the overall potential value of the LSORD for training. Eleven items were rated on a 5-point scale, with 1 = POOR, 3 = FAIR, and 5 = OUTSTANDING. Results of the ratings are summarized in Table B-1.

The "degree of realism of the night carrier approach scene from a waving perspective" was given the lowest mean rating, 3.35. None of the LSOs rated the scene realism as OUTSTANDING, but 95% rated it FAIR or better. Only 1 LSO rated it below FAIR.

The follow-up question on "night carrier approach scene realism" asked about its "adequacy for LSO training." The mean rating was 4.00, the second highest of the 11 items, surpassed only by the "LSORD overall potential value to LSO training" at 4.20.

The "degree of realism of the LSO workstation" received a relatively low rating of 3.35. Only 55% of the LSOs rated it better than FAIR. No one rated it OUTSTANDING, and 1 LSO rated it below FAIR. The LSO workstation console is not recessed into the deck, as it is aboard ship; therefore, it appears much higher and closer in the LSO's visual field. The term "workstation" in the question was general, so it is difficult to judge what aspects of the LSO

TABLE B-1. MEAN RATINGS OF THE LSORD AND ITS FEATURES
(3 = FAIR, 5 = OUTSTANDING)

		Standard Deviation
4.30		
4.20	LSORD OVERALL POTENTIAL VALUE TO LSO TRAINING	(.77)
4.10		
4.00	NIGHT CARRIER APPROACH SCENE, ADEQUACY FOR TRAINING	(.73)
	LSO WORKSTATION, ADEQUACY OF CONTROLS FOR LSO TRAINING	(.92)
3.90	LSO TRAINEE EVALUATION CAPABILITY, WITH INSTRUCTOR AT NCLT CONSOLE	(1.02)
	SIMULATED AIRCRAFT DYNAMICS, ADEQUACY FOR TRAINING	(.81)
3.80		
	LSO TRAINEE EVALUATION CAPABILITY, WITH INSTRUCTOR IN "IGLOO"	(.91)
3.70		
3.60	LSO WORKSTATION, ADEQUACY OF SOUND SIMULATION FOR TRAINING	(.60)
	LSO WORKSTATION, ADEQUACY OF CONSOLE DISPLAYS FOR TRAINING	(.94)
	SIMULATED AIRCRAFT DYNAMICS, REALISM FOR WAVING	(.77)
3.50	LSO WORKSTATION, REALISM FOR WAVING	(.61)
3.40		
	NIGHT CARRIER APPROACH SCENE, REALISM FOR WAVING	(.59)
3.30		
3.20		
3.10		
3.00		

workstation seemed unrealistic to the LSOs. In addition, an "unrealistic" workstation does not necessarily imply a lack of training effectiveness.

This issue was addressed in the next three questions which dealt with the "adequacy for training" of different aspects of the LSORD workstation. The "adequacy of LSO console displays for LSO training" received a moderately low mean rating of 3.55. However, there was a wide range of LSO responses. Three LSOs rated it OUTSTANDING, while 3 rated it below FAIR. Again, it is not possible to determine what aspects of the console displays contributed to the relatively low mean rating and the variability of LSO responses.

The "adequacy of LSO controls for LSO training" received one of the highest mean ratings, 4.00. Six LSOs (37%) rated the LSO controls OUTSTANDING. The controls in the LSORD are identical to those used aboard ship, including the LSO hand switch (pickle), radio handset and MOVLAS. It would be hard to improve the training effectiveness of these LSO controls, so it is not surprising that this category received a very high rating.

The "adequacy of sound simulation for LSO training" was given a moderate mean rating by the LSOs, 3.60. An improvement in the selection of the recorded deck noise has been proposed for the LSORD, partly to reduce the amount of propeller noise. The deck noise probably affects training only to the extent that it masks the simulated engine noise of the approaching A-7.

Two questions were asked about the simulated aircraft dynamics. Their "realism from a waving perspective" received a moderately low rating of 3.53. One LSO rated it below FAIR, but 2 LSOs rated it OUTSTANDING. By contrast, the "adequacy of the simulated aircraft dynamics for LSO training" received a relatively high mean rating of 3.89.

It is interesting to note that "simulated aircraft dynamics" questions, as well as the "night carrier approach scene" questions, received relatively low ratings for "degree of realism", but a high rating for "adequacy for LSO training." The relationship between simulator fidelity and training effectiveness has been the topic of much debate by training experts. Extrapolating from the LSOs responses to the survey, they appeared to be stating that LSORD departures from "realism" were noticeable, but not expected to detract from LSO training. A more detailed analysis of this issue may be warranted, since the LSO task involves complex perceptual processing. The LSOs who responded to the survey may or may not have been able to assess accurately which departures from "realism" would affect the training potential of the LSORD.

The adequacy of LSO trainee evaluation was rated higher for the instructor LSO positioned at the NCLT console than when the instructor was stationed inside the LSORD workstation (the igloo). The reverse display is available at the NCLT console, and the instructor has more controls available for managing the training process. Also, the view of the approach for the second man (the instructor) in the igloo is somewhat awkward because of the limited area for proper head and eye position. A potential disadvantage to the instructor being located at the NCLT console is that communications with the LSO trainee are by ICS rather than face to face.

The final question concerned the "overall potential value of the LSORD to LSO training". This item received the highest mean rating, 4.20. A rating of OUTSTANDING was given by 40% of the LSOs, while 40% rated it GOOD and 20% FAIR. The LSOs apparently felt that the total package was more valuable for training than the individual elements, because this overall rating was higher than any other category. Responses to this question may reflect the LSOs desire to receive some training aid, since the primary training method currently is OJT.

In summary, the LSOs who responded to the questionnaire were favorably impressed with the training potential of the LSORD, although some of its features were not given particularly high ratings — namely, the LSO workstation console dislays, the realism of the night carrier approach scene, and the realism of the LSO workstation. Even these items, however, received a mean rating equivalent to between FAIR and GOOD, and nearly half of them rated the overall potential value of the LSORD for LSO training to be OUTSTANDING.

UTILIZATION OF THE LSORD

The LSOs were asked which phases of the LSO training could be meaningfully supported by the Reverse Display, with the following results: 90% positive for Phase II, Field Carrier Landing Practice (FCLP), and 60% positive for Phase III, Carrier Training Observation.

When asked to indicate which phase of LSO training would be best suited for the LSORD, 20% indicated Phase I, 50% Phase II, and 30% Phase III. The explanations which accompanied this response emphasized that the LSO trainee who would most benefit from the LSORD would be one who had seen night carrier operations. Examples of comments from highly experienced LSOs: "(The LSORD) is too hard for people with little or no experience," and "A little too much to comprehend for Phase I. Useful in all phases, though." Dissenting opinions also were voiced by experienced LSOs, citing the advantages of early (Phase I) introduction of the complexities of the LSOs task, "rapid exposure to all types of approaches not normally available (in Phase I and II), hands on the pickle sooner, and (good for Phase I) because it establishes basic techniques and procedures."

The LSOs selected one or more levels of LSO experience for which the LSORD would be suitable for supplemental training. The outcome, shown in Table B-2, corroborates the results from the previous question. The highest category was "slight experience aboard ship." The second place category was a tie between two completely different applications of the LSORD, refresher training ("Wing Qual returning from non-LSO tour of duty") and initial training ("slight FCLP experience"). One LSO commented the LSORD would be suitable as a supplemental training device for all degrees of LSO expertise because "weather and sea conditions make any stage of LSO experience in need of practice."

Another issue in utilization of the LSORD is the level of pilot skill appropriate for flying the NCLT when conducting LSO training. Four categories of pilots were suggested, and the associated percentage of LSOs who favored each was as follows: RAG student pilot, 6%; squadron nugget, 24%; experienced pilot (non-LSO), 18%; and LSO, 53%. When the LSOs were asked to identify

TABLE B-2. PERCENTAGE OF LSOs (N=20) WHO INDICATED THE LEVELS OF LSO EXPERIENCE FOR WHICH THE LSORD WOULD BE A SUITABLE SUPPLEMENTAL TRAINING DEVICE

LSO EXPERIENCE LEVEL	%
Slight Experience Aboard Ship	90
Slight FCLP Experience	65
Squadron Qual.	65
Wing Qual. Returning from Non-LSO Tour	65
Extensive FCLP Experience	50
Extensive Shipboard Experience (but not Wing Qual.)	50
Naive LSO Trainee	45
Wing Qual.	35
Wing Qual. Going to RAG Duty	35
Phase I School Graduate Only	30
Wing Qual. Going to Air Wing Duty	30

their second choice for NCLT pilot, "experienced pilot" was highest with 63%, followed by "squadron nugget" with 19%. These results suggest some scheduling and utilization difficulties for the LSORD. The pilot of last choice for LSO training was the RAG student pilot, but the NCLT is used primarily for training RAG student pilots. Based on the results of this survey, it appears that the effectiveness of LSO training with RAG pilots should be assessed, and LSO training should be scheduled to avoid RAG pilot training, if necessary. However, this is a complex issue due to factors such as work load of the instructor LSO. Further analysis of LSORD utilization and its interaction with pilot training is recommended.

Several items were frequently noted when asked about "system characteristics and/or capabilities...particularly valuable to LSO training." Pitching deck simulation was most frequently noted. MOVLAS and "pickle time" in an adequately simulated night carrier landing environment were also items of significant note.

Several items were frequently noted when asked about needed improvements for LSO training. Overall perceptual difficulties for the "in close" and "at the ramp" portions of the approach, and nose altitude and lineup perception throughout, were most frequently noted. Incorporation of additional aircraft types into the simulation was a frequent suggestion for improving the system.

Notable comments concerning optimum utilization seem to emphasize frequent utilization, use of the device between carrier ops periods (CQ, type training) and utilization by the entire LSO community whenever possible.

LSO PERFORMANCE MEASURES

The LSOs were asked to rate 23 potential measures of LSO performance. The list of candidate measures of LSO performance were not specifically related to the LSORD. The underlying strategy was to allow LSOs to identify reasonable measures of LSO job performance, most of which can be obtained within the NCLT/LSORD system.

Ratings were given on a five-point scale from 1 = definitely not indicative of LSO performance, through 5 = definitely indicative. The mean ratings given for the 23 potential LSO performance measures are shown in Table B-3.

The three highest ratings were for measures which are dependent solely on the LSO and not on a combination of LSO and pilot performance. "Correctness and timeliness of LSO calls" received the highest rating, with 90% of the LSOs rating it DEFINITELY INDICATIVE. The next two candidate performance measures with highest ratings were "correct recognition of glideslope, lineup, and AOA deviations," and "MOVLAS positioning accuracy."

The remaining 20 items all related to aircraft flight parameters or landing outcome. These variables all are composite of the performance of the pilot, aircraft, and LSO. Therefore, the measures tend to be influenced by the LSO, but not directly controlled by him.

TABLE B-3. MEAN AND STANDARD DEVIATION OF LSO RATINGS
OF CANDIDATE LSO PERFORMANCE MEASURES

(5 = Definitely Indicative of LSO Performance Effectiveness
5 = Indicative of LSO Performance Effectiveness
3 = Possibly Indicative of LSO Performance Effectiveness
2 = Probably Not Indicative of LSO Performance Effectiveness)

	Candidate Performance Measures	Mean	S.D.
1.	Correctness and Timeliness of LSO Calls	4.90	.31
2.	Correct Recognition of G.S., L.U., AOA Deviations	4.75	.44
3.	MOVLAS Positioning Accuracy	4.60	.50
4.	Ramp Strike Rate	4.26	.87
5.	Sink Rate at Touchdown	3.95	.69
6.	Line Up Deviations at the Ramp	3.89	.74
7.	Sink Rate at the Ramp	3.80	.76
8.	Glide Slope Deviations During Approach	3.79	.98
9.	Boarding Rate	3.70	.73
10.	Drift Rate at the Ramp	3.68	.95
11.	Hook to Ramp Distance	3.61	.70
12.	Wave Off Rate	3.60	.94
13.	Line Up at Touchdown	3.58	1.07
14.	Sink Rate Variation During Approach	3.58	.96
15.	Line Up Deviations During Approach	3.53	1.17
16.	Drift Rate at Touchdown	3.50	.83
17.	Angle of Attack Deviation at Ramp	3.32	.67
18.	Angle of Attack Deviations During Approach	3.20	1.06
19.	Bolter Rate	3.16	.69
20.	Drift Rate Variation During Approach	3.00	1.17
21.	Wire	2.95	.60
22.	Rough Nose	2.95	1.00
23.	Rough Power	2.65	.86

The highest rating for this type of measure was "ramp strike rate," followed by "sink rate at touchdown," and "line-up deviations at the ramp." The lowest ratings were given for measures that most directly relate to pilot technique — "rough nose" and "rough power." These measures were rated, at best, as "possibly indicative" of LSO performance.

A formal definition of the highest rated performance measure, "correctness and timeliness of LSO calls" is currently being developed in another NAVTRAEQUIPCEN project Borden and McCauley, (1978).[B-1].

A related measure that was suggested in the questionnaire by one of the LSOs, was "ability to call the pass correctly most of the time."

Unfortunately, from the viewpoint of ease of performance measurement, it is the composite (pilot/aircraft/LSO) measures that are easiest to obtain from the NCLT software. "Correctness" of LSO calls currently is a subjective judgment, not amenable to measurement within the NCLT/LSORD system. Advances in the NCLT pilot performance measurement system may enable it to support LSO trainee evaluation in the LSORD.

B-1. G.J. Borden and M.E. McCauley, Computer Based LSO Carrier Aircraft Recovery Model (Progress Report), Human Performance Research, Inc., 1978.

APPENDIX C

QUESTIONNAIRE

EVALUATION OF LSO REVERSE DISPLAY

The Navy is conducting an evaluation of the LSO Reverse Display portion of the A7E NCLT as an LSO training tool. Commentary from the LSO community is an important part of this evaluation. Your voluntary responses to the questions on this survey will be very beneficial to the establishment of an effective role for the Reverse Display in LSO training.

The following items require a scaled rating of LSO Reverse Display characteristics and/or capabilities. With the 1 to 5 scale, a 5 is for outstanding, 3 is for fair and 1 is for poor.

	1	2	3	4	5
1. Night carrier approach scene from an LSO's perspective:					
- degree of realism from a "waving" perspective?					
- adequacy for LSO training?					
2. LSO workstation environment:					
- degree of realism from a "waving" perspective?					
- adequacy of LSO console displays for LSO training?					
- adequacy of LSO controls for LSO training					
- adequacy of sound simulation for LSO training?					
3. Simulated aircraft dynamics:					
- degree of realism from a "waving" perspective?					
- adequacy for LSO training?					
4. Adequacy of LSO trainee evaluation:					
- with instructor stationed at NCLT console?					
- with instructor stationed in the "igloo"?					
5. Overall potential value to LSO training?					

The following items are concerned with utilization of the LSO Reverse Display. In answering the questions, keep in mind that the LSO Reverse Display will be supplemental to other training media (such as academics, FCLP operations, CV operations), not a stand-alone training device.

6. What phase(s) of LSO training can be meaningfully supported by the LSO Reverse Display?
   _____ Phase I
   _____ Phase II
   _____ Phase III
   Amplify if desired____

   ____

7. For which phase of LSO training is the LSO Reverse Display <u>best</u> suited?
   ______________ Please explain ______________________________

   ____

8. For what level(s) of trainee and LSO experience is the LSO Reverse Display suitable as a supplemental training device? (Check as many as you feel are appropriate.)

_____ naive LSO trainee
_____ Phase I school graduate only
_____ slight FCLP experience
_____ extensive FCLP experience
_____ slight experience aboard ship
_____ significant experience aboard ship (Squadron Qual)
_____ extensive shipboard experience (but not yet Wing Qual)
_____ Wing Qual
_____ Wing Qual LSO going to RAG LSO duty
_____ Wing Qual LSO going to Air Wing LSO duty
_____ Wing Qual LSO returning from non-LSO tour of duty

Amplify if desired ____

____

____

9. What pilot skill level(s) should be used to fly the NCLT when conducting LSO training? (Please note your first and second choices with a 1 and a 2.)

_____ RAG student pilot
_____ squadron "nugget"
_____ experienced pilot (non-LSO)
_____ LSO
_____ Other (specify)

Please explain ____

____

10. Please comment on specific system characteristics and/or capabilities which you feel are particularly valuable to LSO training:

____

____

11. Please comment on specific system characteristics and/or capabilities which you feel need improvement for LSO training:

____

____

12. Comments or ideas on optimum utilization of the Reverse Display for LSO training?

____

____

____

LSO PERFORMANCE MEASUREMENT

Measurement and evaluation of LSO and trainee performance has historically been very subjective. However, there appears to be a high degree of consistency among skilled LSOs in the evaluation of trainees. Earlier studies have identified several qualitative characteristics of a successful LSO. Reaction under stress, perceptual ability, motivation and the ability to instill confidence were rated as the most important characteristics of the successful LSO. The Navy is attempting to determine objective and quantitative measures of LSO and trainee performance effectiveness. These measures will be very valuable as instructor aids in LSO training systems. This survey gives you an opportunity to assess the merits of candidate objective measure.

In your assessment of the measurement items keep in mind several factors. First, there is probably no single measure of LSO performance quality. There is likely to be a weighted combination of several measures. You may feel that some of the items listed below are only indicative of pilot performance. Over a large sample of approaches with different pilots, the influences of pilot performance should balance out, allowing for reliable inferences of LSO performance quality. Therefore, measures such as "boarding rate", "hook to ramp" etc. may prove to be legitimate indicators of LSO performance. Notice that some measures are positive indices (such as "boarding rate") and some are inverse indices (such as "ramp strike rate"). Your responses are only concerned with whether you think LSO performance effectiveness has significant influence (either positive or negative) on the particular measure in question. Also keep in mind that there is no intent of eliminating instructor LSO judgement from the trainee evaluation process. Objective, quantitative measures of LSO performance are intended to be aids.

In selecting your responses to the candidate performance measures below, use the following rating guidelines:

1 = definitely not indicative of LSO performance effectiveness
2 = probably not indicative of LSO performance effectiveness
3 = possibly indicative of LSO performance effectiveness
4 = indicative of LSO performance effectiveness
5 = definitely indicative of LSO performance effectiveness

Use an X to indicate your selection. Space is provided for additional measures that you consider appropriate. There is also space for any amplifying comments that you desire to include. Use the back of the sheet if necessary.

CANDIDATE MEASURES OF LSO PERFORMANCE	RATING 5	4	3	2	1
1. hook-to-ramp distance					
2. lineup deviation at ramp					
3. AOA deviation at ramp					
4. wire					
5. lineup position at touchdown					
6. sink rate at touchdown					
7. drift rate at touchdown					
8. sink rate at ramp					
9. drift rate at ramp					
10. bolter rate					
11. waveoff rate					
12. ramp strike rate					
13. boarding rate					
14. MOVLAS positioning accuracy					
15. correct recognition of glideslope, lineup, AOA deviations					
16. correctness and timeliness of LSO calls					
17. glideslope deviations during approach					
18. lineup deviations during approach					
19. AOA deviations during approach					
20. roughness of power during approach					
21. roughness of nose during approach					
22. sink rate variation during approach					
23. drift rate variation during approach					
Others:					

AMPLIFYING COMMENTS:

The following personal information is desired in order to provide demographic data for the survey sample:

a. Years as LSO (including trainee time) ________

b. Qual levels attained and approximate dates:
   - Phase I School ________
   - Field ________
   - Squadron ________
   - Team Leader ________
   - Wing ________
   - Training ________
   - Staff ________

c. LSO Tours completed:
   - Squadron ________
   - RAG ________
   - TRACOM ________
   - Wing ________
   - PAX River ________
   - Other (Specify) ________

d. Specify current tour of duty: ________

e. Primary aircraft flown: ________

f. Carrier landings (approximate): day ________ night ________

g. Total military flight hours: ________

h. Cruises completed ________

i. Do you have significant experience instructing pilots in the A7E NCLT? _____ Yes _____ No If yes, have you worked with LSO trainees in Reverse Display? _____ Yes _____ No

j. Name/rank ________

Unit/location ________

Address ________

____

Phone: autovon ________ commercial ________

APPENDIX D

SUBJECTIVE EVALUATION OF LSORD VISUAL SYSTEM

BACKGROUND

As part of this study to assess the training effectiveness of the LSORD, particular attention was given to its visual characteristics because of their prime importance for training effectiveness. This section presents the results of the evaluation of the LSORD visual system.

The visual characteristics discussed here are primarily in terms of perceptual and appearance characteristics rather than engineering or hardware characteristics. The general nature of the visual display, its representational characteristics, factors affecting its suitability for training, and current and recommended uses for training will be discussed in succession.

The LSORD visual display consists of two, 25-inch diagonal, color CRTs abutted horizontally and mounted at eye height in the cylindrical wall of the LSO training station, referred to as the "igloo". From the LSOs design eye point the two CRTs provide a 80° horizontal by 32° vertical field of view. Optical elements in front of the CRT place the display nominally at optical infinity. The floor of the igloo is adjustable vertically to allow proper eye height positioning. The LSO's eyes must be properly positioned within a fairly restricted viewing volume to assure a correct perspective view of the display and to avoid the appearance of scene distortions. Line segments on the wall of the igloo extend the horizon line presented on the CRTs. Point light sources in the dome of the igloo represent a star field. The brightness of the horizon segments on the wall and the star field are adjustable. The ambient illumination level within the igloo, which can be either red or white light, and the illumination level of the lights on the LSO console are also adjustable.

The displayed scene is produced calligraphically. That is, points and lines are drawn individually as opposed to painting a full screen raster display as done in commercial television. Calligraphic displays have a darker background, and the potential for greater highlight brightness, thereby permitting greater image contrast than is possible with raster displays. Calligraphic displays are more limited than raster displays in the number of points and lines that can be displayed. Also, calligraphic systems are severely restricted in the presentation of shaded, i.e., solid looking, surfaces because many lines must be painted to shade a surface. Thus calligraphic displays are generally suitable only for simulation of night scenes where large amounts of detail and surface features are not apparent in the real world.

The scenes which can be presented consist of views from the LSO platform aboard several different aircraft carriers. The viewpoint of the display of the CRT on the right is oriented toward the approach path over the stern of the recovery deck. The CRT on the left extends the view across the deck. The LSO can see the same white and red deck and edge lighting he would see on a carrier. The deck status light, red (foul deck) or green (clear deck), also appears in the scene. The edge of the carrier is drawn in blue to outline the

appearance of the form of the carrier deck, which normally would be seen in the real world. The horizon is represented by a blue line at the proper depression angle. The mast lights of the plane guard destroyer appear in the scene. A star field is not included in the scene, i.e., the sky background is uniformly dark.

The representation of the approaching airplane, an A7E, consists of wing-tip lights, red on the left and green on the right, the approach or angle of attack lights, green, yellow or red as appropriate, and conditionally present depending on whether the aircraft landing gear is up or down. The white tail light appears when it is not occluded by some portion of the aircraft structure. The outline of the aircraft is represented by blue lines and is a wire-frame outline, i.e., the aircraft image is transparent. Lines and wing-tip lights which would normally be occluded by the aircraft structure can be seen. The apparent intensity of the aircraft lights and outline increases with decreasing distance from the carrier similar to the real world. The rate of increase in apparent intensity is not necessarily accurate but is easily perceived.

When the aircraft is beyond one mile from the carrier the displayed separation between the wing-tip lights can be up to twice the actual separation and progressively shrinks to accurate scale at a distance of one mile. This exaggeration was incorporated to overcome resolution limits of the display and allow the LSO to resolve the wing-tip lights at aircraft distances where, it is presumed, he would be able to do so in the real world. Within one mile from the carrier the size and other perspective changes of the aircraft image are designed to be accurate.

A novel feature of the LSORD visual display is that the line of sight of the display follows the aircraft as it passes by the LSO. This scene rotation permits the LSO to visually follow the progress of the aircraft through the complete recovery or bolter cycle. With a stationary line of sight the aircraft would disappear off the left edge of the display when it passed approximately 60° to the left of the line of sight. The scene rotation feature appears to have both good and bad effects which will be discussed later.

The NCLT and LSORD simulation have the capability of displaying a pitching deck. In the LSO's display, the pitching deck is apparent from the relative movement of the ramp with respect to the horizon. The display horizon remains coincident with the horizon line segments on the wall of the igloo as it should. The igloo is not equipped with a motion base so all information about the pitching deck comes from the visual display.

PERCEPTUAL EVALUATION OF THE LSORD VISUAL SYSTEM

The perceptual characteristics of the LSORD visual system were evaluated by questioning LSOs familiar with the LSORD and by subsequent examination of the LSORD by the evaluation team. In the latter evaluation numerous approaches were observed with particular attention to criticisms of the display which were expressed by the LSOs.

In general, LSO comments and ratings of the characteristics of the LSORD were favorable. Some apparent perceptual problems with the display were noted. But, overall, none of the problems were considered to be serious enough by the LSOs to compromise the training value of the LSORD.

The evaluation team's impressions of the display were also favorable and no major deficiencies in the visual presentation were discovered. While eyeball evaluations of visual displays, particularly by non-users, are risky at best, the background of the evaluation team was appropriate to the task. One of the members of the evaluation team was a former LSO, one has had extensive experience watching approaches from the LSO position while monitoring LSO performance during day and night FCLP and carrier operations, two are specialists in perception and one is extensively involved in work on visual simulation requirements.

Problems with the visual display identified by the LSOs include: occasional color separation (white and yellow lights appear decomposed into primary colors, particularly red and green) in some areas of the display; jitter of the plane guard destroyer lights and aircraft wing-tip lights; some distracting reflections on the display face; difficulties judging lineup and glideslope "in close" and "at the ramp"; too early a start of scene rotation; an apparent sudden drop of the aircraft during scene rotation; difficulty in judging nose attitude and quickly detecting nose attitude changes; judging lineup errors. These are discussed below.

COLOR COVERGENCE. During the course of a day, the color alignment of the CRTs may go out of adjustment. Thus, colored lights, such as the AOA indexer lights will appear doubled, i.e., two points of light will appear next to each other although only one light should be seen.

A range of colors is generated in the displayed scene by exciting, in the proper proportions, the red, green, and blue phosphors on the surface of the CRT screen. For example, the appearance of yellow is basically achieved by exciting adjacent red and green phosphors. The eye perceives the combination of red and green light as yellow. The different colored phosphors are spaced closely so that when adjacent phosphors of different colors are excited only a single point of light is apparent to the viewer. The color of the point of light will depend on the relative intensity of the different colored phosphors which make up the point. If the electron beams which excite the phosphors do not converge properly then non-adjacent phosphors will be excited and what should appear as a single, colored point of light will be seen as two points of light of different colors. In the LSORD poor color convergence is most obvious and disturbing for the yellow AOA indexer light. If color convergence is out of adjustment, the yellow light will appear as a pair of lights, one green and one red. Because of the importance of the information conveyed by the AOA indexer lights, proper color convergence must be maintained.

Recommendation - Achieving proper color convergence is a simple technical matter involving adjustment of the CRT beam deflection circuitry. Instructors using the LSORD should pay attention to the appearance of colored lights in the display and be sure that proper color convergence is maintained.

A better solution to the color convergence problem would be to improve the long term stability of the beam deflection circuitry so that users of the LSORD need not be burdened with the task of frequently checking and adjusting the color convergence of the displays. It is therefore recommended that the color convergence problem be investigated by a technically qualified individual with the objective of improving the long term stability of the color convergence in the LSORD.

JITTER. LSOs and the evaluation team noticed that the mast lights of the plane guard destroyer appeared to jitter slightly. LSOs have also reported noticing some jitter of the aircraft wing-tip lights. The cause of the jitter is probably due to either the limitation of the accuracy of the calculation of the position of the light points, or the size of the separation between the discrete points on the screen at which the lights may appear. The effect, in either case, is that the displayed position of lights in the scene will fluctuate randomly (jitter) between adjacent, but noticeably distinct, points on the screen. Other than being slightly distracting, it is not likely that a slight amount of jitter will affect the training effectiveness of the LSORD. If jitter is apparent to an LSO he will quickly learn to discount it as a small anomaly in the simulation.

Recommendation - Because of the critical cue importance of the relative alignment of the AOA indexer lights and the wing-tip lights, it may be worthwhile to investigate the cause of the jitter and make the necessary fix.

EXTRANEOUS REFLECTIONS. The inside of the igloo is dark. Reflections from the CRT display are easily noticed. Some reflections originate within the display itself and others come from lights on the LSO console. Lights on the aircraft increase in intensity as it approaches the carrier. At some distance the aircraft lights are sufficiently intense to cause reflections off the inside surface of the collimating lens in front of the CRT and appear on the CRT face. The apparent intensity of these internal reflections is fairly weak and probably do not cause any significant problems. Light from the LSO console and the MOVLAS position indicator in particular, can cause very intense reflections to be seen on the surface of the display. Since the intensity of these lights is adjustable the reflections easily can be avoided by maintaining the intensity of the console and MOVLAS lights at the lowest level consistent with their being visible.

Recommendation - No technical fix for the reflections, internal or external to the display, is necessary. Instructors, however, should check to be sure that the console lights are kept at a sufficiently low intensity to avoid the appearance of the reflections on the display surface.

AMBIENT ILLUMINATION LEVEL. No problems associated with the ambient illumination in the igloo of the LSORD have been reported. However, because of the importance of the effects of the ambient light level on perception and training practices in the LSORD it seemed appropriate to make some comments on ambient illumination level.

The ambient lighting in the LSORD igloo is provided by both red and white lighting systems which are independently adjustable in intensity. Normally, the intensity of the light in the igloo is maintained at a very low level so that features of the room are not visible other than the star field and extended horizon line.

There are several advantages to maintaining a low ambient light level in the igloo, all of which are not necessarily obvious. It is worth mentioning these reasons to encourage the practice of maintaining a low ambient light level in the igloo. First, the low ambient light level enhances the apparent contrast of the dim lines, such as the carrier deck outline, in the display.

Second, the entire simulation appears more realistically as a night environment which reduces the possibility of perceptual errors in judging distance and aircraft position due to conflicts of cues presented in the scene and those which can occur due to perceiving the characteristics of the simulation environment, i.e., the relatively near walls, edges of the CRT and reflections.

Third, each LSO will work in an environment almost as dark as on a real carrier. This is important because visual abilities at night vary considerably among individuals. For example, acuity and contrast sensitivity can be very different for two individuals who have equal acuity in the day. A major reason for this difference is due to a phenomena known as night myopia, which is a focusing of the eyes to a nearer distance than appropriate.

In the real world and the LSORD, the important features of the scene, i.e., the aircraft and deck lines and lighting appear at a distance greater than 20 feet which requires far focusing of the eyes. In dark environments, however, the majority of individuals are unable to achieve far focus. That is, they are subject to night myopia and focus to a nearer distance than they should. The amount of night myopia exhibited varies considerably among individuals. The greater the night myopia, the worse will be acuity and contrast sensitivity.

Normally, an individual does not notice the effects of night myopia, because he has never seen the night environment in any other way. Each individual, however, learns to interpret nighttime scenes according to the way they appear to him or her. Since the low light level in the LSORD approximates a night environment, each LSO will use the same visual ability he has in the real night environment. If higher ambient light levels were used in the LSORD, LSOs would be using their daytime visual abilities and not have the training benefit of being required to use their individually determined night visual abilities. That is, their visual tasks would be easier than they probably are under real night conditions.

Working in low ambient light levels in the LSORD requires some dark adaptation. Three to five minutes in the darkened LSORD igloo is sufficient time to adapt after leaving brightly lighted areas such as the exterior offices or outdoors. Maintaining the hall leading to the igloo at a dim light level helps to promote and maintain dark adaptation and avoids the need to light seal the igloo. The interior lights of the igloo can be raised for

discussions or other training purposes without requiring another period of dark adaptation before dimming them again to view the display as long as the lights are not turned up too high. Using either the red or white lights is a matter of choice. Red lights are customarily used to preserve or permit quick recovery of dark adaptation of peripheral vision. Because the LSORD environment is not actually as dark as real night, and the features of the scene including the star field and extended horizon line are actually brighter than they are in the real world, using dim red lighting in the LSORD does not offer any significant practical advantage over using dim white lighting. Either lighting system can be used without any serious consequences for dark adaptation when it is necessary to increase the ambient illumination for discussion or other training purposes.

Recommendation - The practice of maintaining a dark ambient environment in the igloo is encouraged. The minor problems of waiting a few minutes for initial dark adaptation and a little fumbling in the dark is greatly offset by the advantages of working with the LSORD under conditions of darkness similar to that of the real world. When it is necessary to temporarily raise the lights in the igloo, either the red or white lighting system can be used but the light level should be no higher than necessary to avoid the need to re-adapt to the dark.

DIFFICULTIES IN JUDGING LINEUP AND GLIDESLOPE. The difficulties of judging lineup, distance and glideslope are probably interrelated and result from lack of visual cues to distance although this is by no means certain. Difficulty in the perception of distance in the LSORD is a likely cause of the difficulties in perceiving lineup and glideslope. A discussion of factors that may affect distance perception in the LSORD is given below:

1. <u>Importance of distance perception in the LSO task</u>. Even under the best of circumstances in the real world the LSO must perform a difficult perceptual task. While waving an approach the LSO principally is concerned with the aircraft's position and change of position in lineup and glideslope. To assess whether an aircraft is properly lined up and on glideslope the LSO must be able to perceive accurately the distance of the aircraft from the carrier.

The LSO views the approach path from an off-angle position on the port side of the carrier, approximately 80 to 100 feet from the centerline. The elevation and azimuth angles of the LSO's line of sight to the aircraft become shallower and more to the left, respectively, as the aircraft moves closer to the carrier. The LSO implicitly or explicitly uses fixed references in his field of view such as the ramp, deck edge, lighting, horizon, and/or other features to judge whether the azimuth angle (lineup) and elevation angle (glideslope) of the aircraft are correct. Whether a particular position of the aircraft in azimuth and elevation, relative to the features in the LSO's field of view, indicates correct or incorrect lineup and/or glideslope depends on the distance of the aircraft from the carrier. A particular combination of elevation and azimuth angle to the aircraft indicates correct lineup and glideslope only for one particular distance. If the aircraft were more distant the particular angles would indicate that the aircraft is to the right and low. At a nearer distance the same angles would indicate that the

aircraft is high and to the left. Thus, the accuracy of the LSO's perceptions of lineup and glideslope are critically related to his ability to accurately perceive aircraft distance.

2. Distance cues available to the LSO. In the real world recovery environment, essentially the same types of distance cues are available during both night and day, but they are not as salient at night. The types of visual cues to distance that are available include size (separation between wing-tip lights), relative motion, relative intensity (brightness) of the aircraft lights, and stereoscopic depth perception. The first three distance cues listed do not require the use of two eyes and are therefore referred to as monocular cues. The last cue listed requires viewing with two eyes and is therefore called a binocular cue. It should be understood that although an LSO is said to be using these distance cues, it does not mean that he is consciously aware of the process. Normally, an LSO, like other people, experiences the impression of distance directly and is not aware of the perceptual activities involved in using the various distance cues. Each of the cues discussed below can be explicitly noticed with some conscious direction of attention to them, but usually only the results of using these cues, i.e., the perception of distance, is experienced. In the following, the cues to distance are discussed as if deliberate attention was directed to them, but this is only a convention to simplify explanation.

2a. Size. Size is probably the most important distance cue available to the LSO. There are two related ways that the LSO can use size to judge distance to the aircraft. First, the angular size of the separation between the wing-tip lights can be compared to features such as the separation between the ramp lights which remain at a fixed distance and size in the LSO's field of view. These fixed features are, in effect, rulers with which to compare the size of the separation between the aircraft wing-tip lights. Since the angular size of the separation between the wing-tip lights is directly related to the distance of the aircraft, the relative size can be perceptually translated into distance of the aircraft. Even without other features to make size comparisons, the LSO, through experience, becomes familiar with the angular size of the separation between the wing-tip lights throughout the approach and can use this remembered size information to judge distance of the aircraft.

2b. Relative motion. An aircraft on lineup and glideslope as it approaches the carrier will appear to move downward and to the left in the LSO's field of view. The rate of these movements will increase as the aircraft gets closer to the carrier. The leftward and downward rates of movement at any point in time during the approach are cues to the distance of the aircraft. These relative motion cues, however, are partially ambiguous. If the aircraft is deviating from the desired lineup or glideslope, some component of the relative motion is an indicator of flight path deviation. Since the LSO has other cues to distance and has been observing the continuous process of the approach, he is able to resolve the relative motion cues into the "normal" components of motion which indicate distance and the "abnormal" cues which indicate deviation. The same relative motion cues which are available in the real world are available in the LSORD.

2c. Relative intensity of aircraft lights. The intensity (brightness) of the aircraft wing-tip, AOA indexer and tail lights increases as the aircraft approaches the carrier. At night the intensity of the aircraft lights is a cue to distance. The intensity of the aircraft lights is inversely proportional to the square of the distance of the aircraft from the carrier. For example, when the aircraft is one-quarter mile from the carrier the lights are four times more intense than when the aircraft is one-half mile from the carrier. The absolute intensity of the lights are probably not as much of a cue to distance of the aircraft as is the rate of increase of intensity during the course of the approach.

In the LSORD the intensity of the aircraft lights also increase during the approach. In the LSORD the aircraft lights increase in intensity from the lowest level at a range of 40 miles to the maximum intensity at a range of 100 feet from the LSO position. Because of limitations in the brightness of lights in the LSORD, it is unlikely that the change in light intensity is as great as would occur in the real world. Since the LSO is primarily concerned with aircraft distance from about one mile out to the ramp, it would probably be desirable to have the intensity of the aircraft lights increase over the range possible in the LSORD from the minimum at one or one and one-half miles to the maximum at the ramp. In other words, it would be better to have the usable range of intensity of the LSORD applied to the section of the approach where relative brightness is most useful to the LSO.

2d. Stereopsis. Stereopsis is the ability to discriminate distance using two eyes. In the real world, because each eye has a slightly different viewpoint, the angular relations of objects in the scene are also slightly different for each eye. The human visual system is able to use these slight differences to resolve distance. An imporant point about stereopsis is that it does not provide information about the distance from the observer to some object. Stereopsis only provides information about the distance between two objects in front of the observer. Thus, stereopsis cannot indicate, by itself, the distance from the LSO to the aircraft but can provide very good information about the distance between the ramp and the aircraft.

In the LSORD, distance perception through stereopsis is not possible because all parts of the image on the CRT appear at one distance, i.e., near optical infinity. Even though the LSO views the display with two eyes, there are no real differences in depth between features in the scene. The lack of the stereoscopic visual cue is probably the single most important factor which makes distance perception more difficult in the LSORD than in the real world. It must be stated, however, that providing a stereo display in the LSORD would be very expensive. It would also impose certain constraints on the viewing situation which would probably be more detrimental to the training effectiveness of the LSORD than the absence of the stereoscopic cue to distance. Distance perception can be adequately supported in the LSORD by the non-stereoscopic cues, i.e., the so-called monocular cues, discussed above.

3. Implications for lineup and glideslope perception in the LSORD. The visual cues discussed above are the principal sources of distance information available to the LSO in the real world. The same cues, with the exception of

stereopsis, are available in the LSORD. In both situations, the LSO must be able to accurately perceive aircraft distance in order to accurately perceive lineup and glideslope of the aircraft throughout the approach.

The problems of distance perception, and hence, lineup and glideslope perception, in the LSORD are probably not due to the absence of cues present in the real world, such as stereopsis, but because of the presence of other cues which tell the LSO he is viewing a picture and not the real world. Slight distortions with head movement, viewing a flat scene (stereo cue to flatness), glare from the screen face, a limited field of view, unrealistic color (blue deck edge outline), the dividing line between the CRT screens, and the knowledge that the LSO is looking at a simulated display, are all small factors which accumulate to suggest picture viewing rather than real world viewing. None of these effects disable the LSO from using the cues available in the LSORD but they can alter the viewing situation in subtle ways so that the LSO does not perceive things in the LSORD in exactly the same way as the real world. An LSO develops an acute sensitivity to the perceptual cues necessary to wave aircraft. Because of the sensitivity to perceptual cues, an LSO will also be sensitive to small differences between the real world and the scene displayed in the LSORD.

4. Overcoming perceptual difficulties. The perceptual difficulties reported by the LSOs in judging lineup and glideslope can be overcome in two principal ways. First, the display could be made more realistic by providing a stereoscopic display. Second, they can be overcome through perceptual learning. Providing a stereoscopic display in the LSORD would be very expensive and even if technically and economically feasible, would result in a very small gain in training effectiveness. The gain would be small because the LSORD is already judged by the LSOs to be very realistic and learning in practice of interpreting perceptual cues is only one part of the training in the LSORD.

Through perceptual learning an LSO can overcome the differences between the real world and the LSORD. In the real world an LSO becomes "recalibrated" when going from one type of carrier to another or from FCLP to a carrier. The viewing situations differ only slightly but the LSO must, and does, adjust to these differences. The same type of perceptual recalibration also can occur in the LSORD. There are few fundamental differences in the perceptual situation between the real world and the LSORD. The cue of stereopsis is absent and there may be slight differences in the utility of the available cues, such as relative intensity, and the presence of cues which suggest simulation as opposed to real world viewing. The perceptual learning which occurs through experience in the LSORD will result in the LSO making better use of the available cues and ignoring the extraneous cues to simulation. Perceptual problems which are noticeable when an LSO first encounters the LSORD are likely to disappear with experience in the LSORD.

Perceptual learning does not necessarily require deliberate instructional effort, but it can speed up the process. Certain instructional aids in the LSORD can be used to this end. For example, the cross hairs showing lineup and glideslope position, if presented momentarily by the instructor during the

course of an approach, would help the LSO to learn where the aircraft image should appear for a good approach. The cross hairs cannot be used continuously, however, because the object is to have the LSO quickly learn to interpret the intrinsic cues in the scene and not to depend on artificial cues.

It should be emphasized that learning to interpret the LSORD scene will not cause misperceptions in the real world. The LSO will learn to make better use of the cues available in the LSORD, which are also present in the real world, to compensate for those cues, such as stereopsis, that are absent. The LSO will not learn to use cues which are unique to the simulation. None appear to be present in the LSORD, and if they were present, they would have to be eliminated. Since the cues to simulation, which the LSO will learn to ignore, are not present in the real world, they will not affect his performance when he waves aircraft in the real world.

In summary, the perceptual problems experienced by the LSOs in judging lineup and glideslope in the LSORD are probably due to difficulties in judging distance. Because most of the real world cues are available in the LSORD, an LSO, through experience, will learn to make better use of these cues and ignore the cues that are unique to the simulation.

Recommendation - It is probably not worthwhile to try to increase the realism of the simulation by providing a stereoscopic display to overcome initial difficulties in perceiving lineup and glideslope. But is is important to recognize that a period of perceptual learning will be necessary to overcome these difficulties and this may be facilitated by instruction and use of the aids available in the LSORD.

PERCEPTUAL PROBLEMS ASSOCIATED WITH SCENE ROTATION. An unusual feature of the LSORD simulation is the automatic rotation of the LSO's line of sight at about the time the aircraft passes 45° abeam of the LSO. The purpose of scene rotation is to allow the LSO to follow the approach through to its conclusion, either a trap or a bolter. Without scene rotation the aircraft image would pass through the display area of the left-hand CRT and disappear before touchdown. Scene rotation keeps the line of sight to the aircraft approximately centered in the right-hand CRT; the aircraft image never passes into the left-hand CRT area. If the LSO's eyes are not positioned in exactly the right place a slight discontinuity in the displayed scene is apparent where the two CRTs abutt. A secondary effect of scene rotation therefore is to prevent the aircraft image from crossing the CRT boundary and thereby preclude any possible distortion of the aircraft image or its path just prior to touchdown.

LSOs have reported two minor perceptual problems which occur during scene rotation, difficulty in assessing final actions of the aircraft and an apparent sudden 'drop' of the aircraft.

1. <u>Start of scene rotation</u>. Some LSOs, who have had extensive experience with the LSORD, have commented that scene rotation occurs a little too early and causes some disruption in the LSO's ability to assess the final actions of the aircraft as it passes from the ramp to the touchdown point. One LSO has suggested that scene rotation should start about one second later

than it does currently. The probable benefit of delaying scene rotation by one second or so would be to maintain the stable frame of reference provided by the carrier deck and other features in the background. A stable background is probably necessary to notice final actions of the aircraft, such as diving for the deck or last minute attitude changes.

2. 'Drop' of the aircraft during scene rotation. During scene rotation, a sudden 'drop' of the aircraft is apparent as it passes by. This drop of the aircraft also was noticeable by the evaluation team. The cause of the drop is very likely to be due to a perceptual effect of scene rotation. During scene rotation, the line of sight tracks the aircraft and the image of the aircraft, while moving horizontally with respect to the background of the scene, remains horizontally stationary with respect to the frame of reference provided by the CRT face. The aircraft image, however, continues to descend, i.e., move vertically, with respect to both the background and the CRT face. The onset of scene rotation, in effect, stops the apparent horizontal travel of the aircraft while descent appears to proceed normally. Thus, the vertical component of the aircraft motion is prominent with respect to its horizontal motion and the aircraft appears to drop suddenly.

That this drop is due to the perceptual effects resulting from scene rotation rather than some anomaly in the simulation is readily determined by observing several replays of the sameapproach and alternately concentrating on the aircraft movement with respect to the background and with respect to the frame ofthe CRT. In the former case, the sudden drop is not apparent and in the latter case it is. During these observations particular attention was paid to the movement of the aircraft image in relation to the horizon line and deck edge. No jump or sudden downward movement of the aircraft image was seen.

Scene rotation in the LSORD substitutes for the normal turning of the eyes and head of an LSO following the path of an aircraft during a real world approach and landing. Turning of the eyes and head is a normal activity in everyday life. The human visual system takes these eye and head movements into account and the world appears to remain stable, i.e., does not shift position with shifts in the direction of gaze. Because eye and head movements are not made in the LSORD, there is a perceptual conflict due to the appearance of the rotation of the line of sight and the absence of eye and head movements which normally produce changes in the line of sight. The rotation of the entire scene presented over a fairly wide field of view of the LSORD helps to overcome this conflict and to produce the correct perception, but it does not always compensate completely for the absence of the eye and head movements which accompany a change in the line of sight. Thus, the aircraft image can appear to drop suddenly even though the simulation is correct. LSOs have occasionally commented that when they thought either a one or two wire would be caught on a trap, to their surprise, the LSORD reported a three or four wire caught. This may be a secondary effect of the apparent suddent drop of the aircraft during scene rotation.

Recommendations - Neither of the two reported perceptual problems associated with scene rotation are considered serious and are unlikely to have any

significant effect on the training effectiveness of the LSORD. It is recommended, however, that additional delays of the start of scene rotation be tried and evaluated by experienced LSOs to determine if delaying the start time for scene rotation will improve the ability of LSOs to assess actions of the aircraft after it passes the ramp and before touchdown.

Since the sudden drop of the aircraft image is considered to be a perceptual effect rather than an anomaly in the simulation, no changes in the simulation are likely to be beneficial. Deleting scene rotation would avoid the drop effect but would probably create the more serious deficiency of precluding the LSO from observing the completion of the landing because the aircraft image would quickly pass out of the field of view on the left. It is recommended that in the event an LSO notices the apparent drop of the aircraft during scene rotation that he be told the cause of this effect and be advised to concentrate his attention on the aircraft and background scene.

PROBLEMS IN THE PERCEPTION OF PITCH ATTITUDE/AOA. A distinction must be made between perceptual problems which are the consequence of going from a full cue, real world environment to the slightly restricted cue environment of the LSORD and perceptual problems which are due to errors in the way the real world is represented in simulation. The third type of perceptual problem reported by LSOs, difficulty in judging pitch angle, or angle of attack of the approaching aircraft, is likely to fall in the second category of problems. This is likely, because the pitch angle persists in appearing incorrect to the LSOs even after long periods of experience in the LSORD.

Whether the pitch angle of the aircraft is correctly represented in the simulation cannot be determined simply by looking at the display. The reports by the LSOs indicate that the aircraft consistently has a higher pitch angle than is appropriate for the way the aircraft behaves during the approach. Using the LSO reports as a starting point, it woud be worthwhile to carefully investigate the simulation software to ensure that it is accurately representing the aircraft dynamics during the latter stages of the approach.

Recommendation - The pitch angle problem could be due either to an error in the software or the fact that the aircraft dynamics are not modeled correctly or in sufficient detail to produce the proper visual appearance in the LSORD. Careful comparisons of A-7E aircraft approaches with the LSORD display would probably be useful. In any event, the reported problem of the appearance of the pitch angle of the aircraft in the LSORD should be investigated from a technical standpoint to determine why there is a discrepancy between the appearance of the aircraft pitch angle and how LSOs report it should look.

SUMMARY

In regard to the visual characteristics of the LSORD, no serious deficiencies were discovered in either the design or operation of the display system which would have a major impact on the training effectiveness of the LSORD.

A few problems which should be corrected or investigated further were reported by LSOs familiar with the LSORD. The evaluation team paid particular attention to these problems when working with the LSORD. These problems were either technical, i.e., requiring adjustment or alteration of the display system, or perceptual, i.e., due to differences between the real world visual environment and the simulated environment of the LSORD. None of the perceptual problems were considered serious enough to raise doubts about the training effectiveness of the LSORD. Recommended actions for the problems related to the visual characteristics of LSORD were given following the discussion of each problem.

APPENDIX E

PHASE II SYLLABUS

Assumptions/Considerations:

- Goal of training is for trainee to be able to conduct unsupervised FCLP workup of fleet pilots
- Syllabus tailored to A-7 community (LSO Reverse Display available)
- Trainee enters syllabus with Phase I school, or equivalent preparation
- Multiple instructor LSOs available
- Syllabus extends over two FCLP workup periods
- Syllabus events coordinated with FCLP schedule
- About 4 - 6 trainees per "class"

Learning Strategy:

- Two stage syllabus
- First stage (first FCLP workup period) oriented to early "hands on," basic waving
- Second stage (second FCLP workup period) oriented to pilot training aspects of FCLP and unusual operating conditions

Media:

- FCLP operations
- LSO Reverse Display
- Lectures
- Reference materials (LSO NATOPS, A7 NATOPS, Airfield Ops Manual, LSO Training Guide)
- CV Operations

Syllabus Event Summary:

- FCLP-15
- LSO Reverse Display - 20
- Lectures - 15
- CV Operations - 1

SYLLABUS EVENTS, STAGE I:

I-1 Academic Group Participation 1 hour

Phase II Syllabus Introduction

Topics:

Learning goal and objectives; Stage I LSO waving role
Sequence of syllabus events and media employed
General conduct of training events
Potential variances in sequence and causes; need for flexibility
Reference materials
Review of LSO job responsibilities
Review of general LSO decision making process and influencing factors

I-2 FCLP Day and Night Sessions Group Participation

Introduction to FCLP

Instructor guides general familiarization of FCLP environment and observation of approaches

I-3 Academic Group Participation 45 minutes

Aircraft Flight Characteristics

Topics:

Glideslope, lineup, speed control
Approach systems (APC, DLC, ...)
Approach tendencies, correction limitations
Visual gouges for speed/AOA
Malfunctions relevant to FCLP

I-4 Academic Group Participation 45 minutes

Approach Parameters and Informative Calls

Topics:

Glideslope deviations
Lineup deviations
AOA deviations
Range segments of approach
Correlation of parameters to informative calls

SYLLABUS EVENTS: Stage I (continued)

I-5 FCLP Group Participation

Approach Parameters and Informative Calls

Instructor points out glideslope, lineup, AOA and range variations; also reviews aircraft flight characteristics

I-6 LSORD Group Participation 1½ hours

LSORD Familiarization

Instructor points out features and procedures of LSORD; pairs of trainees spend about 20 minutes each in igloo observing approaches and operating relevant system functions (crosshairs, lighting controls, ...); trainees alternate flying NCLT

LSORD Features:

Canned approaches
Crosshairs
Rerun

I-7 LSORD 2-3 Trainees 1½-2 hours

Glideslope and Informative Calls

Trainee initially observes approaches while instructor guides learning of glideslope deviations and range segments; frequent use of crosshair and rerun; trainee points out deviations by using informative calls; each trainee spends about 35 minutes in igloo.

LSORD Features:

Canned Approaches
Crosshairs
Rerun

I-8 FCLP Group Participation

Glideslope and Informative Calls

Instructor guides trainee detection of glideslope deviations and range segments; trainee points out deviations and use of informative calls

SYLLABUS EVENTS: Stage I (continued)

I-9 LSORD 2-3 Trainees 1½-2 hours

Lineup, AOA and Informative Calls

Initial portion of session is warmup with glideslope and range segments; instructor then guides learning of lineup and AOA deviations; trainee points out deviations by using informative calls

LSORD Features:

Canned approaches
Crosshairs
Rerun

I-10 FCLP Group Participation

Lineup, AOA and Informative Calls

Instructor guides trainee detection of lineup and AOA deviations; trainee points out deviations and use of informative calls

I-11 LSORD 2-3 Trainees 1½-2 hours

Practice

Trainee practices glideslope, lineup and AOA informative calls

LSORD Features:

Crosshairs
Rerun

I-12 Academic Group Participation 1 hour

Waveoff

Topics:

Waveoff window concept
Factors influencing the waveoff decision
Typical waveoff situations
Discussions of aircraft accidents in which the waveoff decision (or non-decision) was a factor

SYLLABUS EVENTS: Stage I (continued)

I-13 LSORD 2-3 Trainees 1½-2 hours

Waveoff

Instructor guides NCLT pilot in the demonstration of approaches requiring waveoff; trainee exercises waveoff decision process; use of voice and pickle included; incorporation of foul deck light into waving scan

LSORD Features:

Canned approaches
Crosshairs
Rerun
Foul deck light

I-14 FCLP Group Participation

FCLP Review

Trainee "talks through" the approaches with instructor, pointing out deviations and appropriate calls to be made, instructor alert for, and points out, waveoff situations

I-15 Academic Group Participation 45 minutes

Pilot Corrections

Topics:

Pilot power and attitude corrections
Pilot neglect of approach cues (glideslope, lineup, AOA, scan breakdown)
Approach parameter trends
Pilot responsiveness factors
New LSO calls - power, attitude, right/left for lineup

I-16 LSORD 2-3 Trainees 1½-2 hours

Power and Attitude

Trainee use of new calls as well as others learned prior; continued emphasis on waveoff

LSORD FEATURES:

Crossnairs
Rerun
"SCORE" display in rerun
Foul deck light

SYLLABUS EVENTS: Stage I (continued)

I-17 FCLP Group Participation

FCLP Review

Trainee "talks through" the approaches with instructor; emphasis on power, attitude and waveoff situations

I-18 LSORD 2-3 Trainees 1½-2 hours

Practice

Trainee exercise waving skills acquired thus far

LSORD Features:

Rerun
Foul deck light

I-19 Academic Group Participation 45 minutes

Remaining LSO Calls

Topics:

Remaining LSO calls and situations for their use
Overall review of the LSO decision process and call repertoire
Non-standard calls to be avoided

I-20 LSORD 2-3 Trainees 1½-2 hours

Practice

Trainee exercise waving skills; emphasis on use of new calls

LSORD Features:

Rerun
Foul deck light

I-21 Academic Group Participation 1 hour

Grading Approaches

Topics:

Grading and pilot diagnosis philosophy
Grading criteria
Diagnostic commentary
LSO shorthand; writing book
Debriefing techniques

I-22 LSORD 2-3 Trainees 1½-2 hours

Grading Approaches

Trainees wave and grade approaches; frequent use of rerun to develop approach recall skill

LSORD Features:

Canned Approaches
Crosshairs
Reruns
Foul deck light

I-23 FCLP Group Participation

FCLP Grading

Trainees wave some approaches (if possible); trainees introduced to grading and diagnostic commentary; trainees observe FCLP debriefing

I-24 LSORD 2-3 Trainees 1½-2 hours

Practice

Trainee practices waving with continued emphasis on grading

LSORD Features:

Crosshairs
Rerun
Foul deck light

I-25 FCLP Group Participation

Trainee wave some approaches (if possible); grade approaches, write book; observe FCLP debrief

I-26 LSORD 2-3 Trainees 1½-2 hours

Practice

Trainee practice waving and grading; trainee debrief NCLT pilot

LSORD Features:

Rerun
Foul deck light

SYLLABUS EVENTS, STAGE I: (continued)

I-27 Academic | Group Participation | 1 hour

Stage I Training Review

Topics:

- Guided group discussion of learning objectives covered in Stage I
- Trainee tendencies observed by instructor in Stage I training
- Brief overview of Stage II training
- Guidance for self learning practice and reading activities for skill reinforcement between stages I and II (encourage LSORD practice, FCLP and CQ observation and review of reference materials)

SYLLABUS EVENTS, STAGE II:

II-1 Academic | Group Participation | 45 minutes

Stage II Training Introduction

- Brief review of Stage I
- Learning goal and objectives of Stage II; LSO instructional role
- Sequence of syllabus events
- General conduct of events
- Potential variances in sequence
- Reference materials

II-2 Academic | Group Participation | 45 minutes

Conducting FCLP

Topics:

- FCLP pattern and procedures
- FCLP equipment setup and utilization
- FCLP safety
- Review of debriefing techniques

II-3 LSORD | 2-3 Trainees | 1½-2 hours

LSORD Review

- Trainee wave, grade and debrief approaches

LSORD Features:

- Crosshairs
- Rerun
- Foul deck light

SYLLABUS EVENTS, STAGE II: (continued)

II-4 FCLP Group Participation

FCLP Setup and Practice

Trainee introduced to equipment setup; wave and grade some approaches

II-5 Academic Group Participation 45 minutes

Critical Pilot Errors

Topics:

Describe critical pilot errors and trends
Typical FCLP error tendencies to watch for
Review accident summaries representative of critical pilot errors

II-6 LSORD 2-3 Trainees 1½-2 hours

Critical Pilot Errors

Trainee shown critical pilot errors; trainee wave, grade, debrief

LSORD Features:

Rerun
Foul deck light
"SCORE" display

II-7 FCLP Group Participation

FCLP Practice

Trainee wave and grade approaches; trainee debrief one pilot

II-8 Academic Group Participation 30 minutes

Pilot Diagnostics

Topics:

Analysis of pilot errors in FCLP
Diagnostic calls to pilot in FCLP

SYLLABUS EVENTS, STAGE II: (continued)

II-9 LSORD 2-3 Trainees 1½-2 hours

Pilot Diagnostics

Trainee wave/grade and provide diagnostic calls to NCLT pilot

LSORD Features:

Rerun
Foul deck light

II-10 FCLP Group Participation

Pilot Diagnostics

Trainee wave and grade approaches; point out to instructor when diagnostic calls would be made; debrief pilots

II-11 LSORD 2-3 Trainees 1½-2 hours

Practice

Trainee exercise LSO skills

LSORD Features:

Rerun
Foul deck light

II-12 FCLP 2-3 Trainees

FCLP Practice

Trainees split waving, grading and debriefing for FCLP session under supervision of instructor

II-13 Academic Group Participation 45 minutes

Unusual Operating Conditions

Topics:

LSO talkdown
Use of cut lights
Aircraft lighting malfunctions
Aircraft malfunctions and emergencies relevant to FCLP
Variations in wind conditions

SYLLABUS EVENTS, STAGE II: (continued)

II-14 LSORD | 2-3 Trainees | 1½-2 hours

Unusual Operating Conditions

Trainee introduced to LSO talkdown, use of cut lights (ZIPLIP/NORDO), aircraft lighting malfunctions and unusual wind variance

LSORD Features:

Rerun
Crosshairs
Foul deck light
FLOLS out
Aircraft lighting malfunctions
NORDO
Wind speed/direction variance

II-15 LSORD | 2-3 Trainees | 1½-2 hours

Practice

Trainee practice, including unusual operating conditions introduced earlier

LSORD Features:

Rerun
Crosshairs
Foul deck light
FLOLS out
Aircraft lighting malfunctions
NORDO
Wind variation

II-16 Academic | Group Participation | 30 minutes

MOVLAS

Topics:

MOVLAS operation
MOVLAS configuration variations
MOVLAS waving technique

SYLLABUS EVENTS, STAGE II: (continued)

II-17 LSORD 2-3 Trainees 1½-2 hours

MOVLAS

Trainee introduced to waving with MOVLAS

LSORD Features:

MOVLAS
Rerun
Crosshairs
Foul deck light

II-18 [illegible] 2-3 Trainees [illegible]

[illegible]

[illegible] practices all LSO skills learned, emphasis on MOVLAS

[illegible]

[illegible] malfunction

[illegible] 2-3 Trainees

[illegible]

[illegible] conduct FCLP under LSO supervision

II-20 LSORD 2-3 Trainees 1½-2 hours

Practice

Trainee practice LSO skills learned

LSORD Features:

Rerun
MOVLAS
Foul deck light
Wind variation
NORDO pilot
FLOLS out

SYLLABUS EVENTS, STAGE II: (continued)

II-21 FCLP 1-2 Trainees

Practice

Trainees conduct FCLP under LSO supervision

II-22 FCLP 2-3 Trainees

MOVLAS

Trainees use MOVLAS for FCLP

II-23 Aboard Ship Group Participation

CQ Observation

Trainees observe CQ operations, perform book writing and observe debriefing; instructor review correlations between FCLP and pilot performance in CV operations

II-24 Academics Group Participation 1 hour

Phase II Training Review

Topics:

Guided group discussion of learning objectives covered
Trainee tendencies noted
Overview of subsequent LSO training
Guidance for self learning (LSORD practice, FCLP, CQ observation)

APPENDIX F

PHASE III LSORD SYLLABUS

Assumptions/Considerations:

Goal of training is for trainee to receive guided instruction and hands on experience in a simulated training environment with most conditions required for Wing LSO Qualification.

Syllabus designed for LSOs from all aircraft communities.

Trainee entry level should include Phase II field qualification and some LSO exposure to night carrier operations.

Training to be supervised by Air Wing LSOs with support from air wing team leaders and LSO school personnel.

Class size of 4-6 trainees.

Modular syllabus designed for injection of LSORD training between CV operations periods prior to and between deployments.

Trainees alternate flying the NCLT during training session; each trainee spends about 30-35 minutes of each session in the "igloo."

Syllabus Strategies:

Sequence - Introduction to night CV operations followed by increasingly complex stages of instruction; five stages:

Stage I - LSORD and Night CV Operations Familiarization
Stage II - Night CV Operations, Introductory Waving
Stage III - Pitching Deck
Stage IV - MOVLAS
Stage V - Unusual Waving Conditions and Situations

Reference Materials:

LSO NATOPS
LSO Guide and Training Plan
LSO Phase I School Guide
CV NATOPS
Ship Air Ops Manual
Air Wing SOP
Accident Summaries

Approach Articles:

"The LSO-Forever an Asset", October 1974
"An LSO's Stand for Safety", February 1975

Approach Articles (continued):

"LSOs - An Endangered Species," October 1975
"The In-Close Waveoff," February 1976
"More on In-Close Waveoffs," February 1976
"Waving: You Can't Take It Personal!," August 1976
"MOVLAS Techniques for Pilots and LSOs," September 1976

Syllabus Event Summary:

LSORD - 26
Academic - 14

Explanation of Syllabus Topical Elements:

a. Sterile conditions - well defined horizon, steady deck, no aircraft malfunctions, no ceiling or visibility restrictions, proficient fleet squadron pilot skill level

b. Pilot variations - moderate to extreme variations of pilot skill in flying approach and in responsiveness to LSO calls

c. Horizon/plane guard - reductions in horizon definition, eventually to non-existent, and removal of plane guard destroyer lights

d. Deck status - extreme situations of late clear deck and foul deck after being clear

e. Wind over deck - moderate to extreme variations in crosswind (right/left) and intensity (high/low)

f. Weather (ceiling/visibility) - reductions in ceiling and visibility to eventually present approaching aircraft break out inside 1/2 mile

g. NORDO - radio failures for LSO or aircraft

h. LSO Talkdown - failure of FLOLS

i. Pitching deck - increasing intensity of pitching deck motion

j. MOVLAS - use of MOVLAS instead of FLOLS

k. aircraft malfunctions/emergencies - hydraulic, instrument, lighting, flight controls, etc.; malfunctions and emergency situations

SYLLABUS EVENTS, STAGE I, LSORD and Night CV Operations Familiarization:

I-1 Academic	Group Participation	1 hour

Syllabus Introduction

Topics:

Phase III LSO Training
Stage I Overview
LSORD Description

I-2 LSORD	Group Participation	1-1/2 - 2 hours

LSORD Familiarization

Instructor points out features of LSORD; pairs of trainees spend about 15-20 minutes in igloo observing approaches and LSORD features.

I-3 Academic	Group Participation	1 hour

LSO Waving Responsibilities

Topics:

Voice calls, pickle use
Approach parameters
Visual Cues
LSO Decision-making

I-4 LSORD	2-3 Trainees	2 hours

Waving Approaches

Trainee observes and waves approaches under sterile operating conditions.

I-5 LSORD	2-3 Trainees	2 hours

Waving Approaches

Trainee waves approaches under sterile operating conditions and is introduced to pitching deck, WOD variations, horizon variations, aircraft lighting malfunctions, weather variations and pilot skill extremes.

SYLLABUS EVENTS, STAGE II, Night CV Operations, Introductory Waving:

II-1 Academic	Group Participation	1 hour

Syllabus Introduction

Topics:

Stage II Overview
LSORD Review
Night CV Ops Review

II-2 LSORD	2-3 Trainees	2 hours

LSORD Review and Waving Refresher

Trainee waves approaches under sterile conditions.

II-3 Academic	Group Participation	1 hour

Review of LSO Responsibilities, Waving Situations

Topics:

Voice calls, pickle use
Approach parameters
Visual Cues
LSO Decision-Making
Situation variables (pilot, aircraft, deck, weather, horizon, etc.)

II-4 LSORD	2-3 Trainees	2 hours

Waving Approaches

Trainee waves approaches under sterile conditions; demonstration of some pilot responsiveness variations; trainee practice making late waveoff to develop feel for waveoff "window."

II-5 Academic	Group Participation	1 hour

Carrier Landing Accident Review

Topics:

Accident descriptions
Accident causes
Role of situation variables in accidents
Role of LSO in prevention of accidents reviewed

SYLLABUS EVENTS, STAGE II (continued):

II-6 LSORD — 2-3 Trainees — 2 hours

Waving Approaches

Same as II-4 plus introduction to deck status (clear/foul) situations.

II-7 LSORD — 2-3 Trainees — 2 hours

Waving Approaches

Same as II-4, II-6 plus introduction to NORDO, LSO Talkdown, reduced horizon definition, WOD variations.

II-8 Academic — Group Participation — 1 hour

Grading and Debriefing Pilots

Topics:

Grading carrier passes
Descriptive commentary for ship operations
Debriefing carrier passes

II-9 LSORD — 2-3 Trainees — 1 hour

Waving Approaches

Practice waving under all conditions introduced thus far; introduction to pitching deck conditions.

SYLLABUS EVENTS, STAGE III, Pitching Deck:

III-1 Academic — Group Participation — 1 hour

Syllabus Introduction

Topics:

Stage III Overview
LSORD Review
Night CV Ops Review

III-2 LSORD — 2-3 Trainees — 1 hour

LSORD Waving Refresher

Trainee waves approaches under the conditions covered in Stage II.

SYLLABUS EVENTS, STAGE III (continued)

III-3 Academic — Group Participation — 1 hour

Pitching Deck

Topics:

Deck motion geometry
FLOLS stabilization
Pitching deck waving techniques
Pitching deck related accidents

III-4 LSORD — 2-3 Trainees — 2 hours

Waving Approaches

Trainee waves approaches under moderate pitching deck conditions with well-defined horizon; also introduced to LSO talkdown under pitching deck conditions.

III-5 LSORD — 2-3 Trainees — 2 hours

Waving Approaches

Trainee waves approaches under moderate pitching deck conditions with minimum horizon definition or with just the plane guard destroyer visible.

III-6 LSORD — 2-3 Trainees — 2 hours

Waving Approaches

Trainee waves approaches under moderate and heavy pitching deck conditions with minimum horizon definition or with just the plane guard destroyer visible.

III-7 LSORD — 2-3 Trainees — 2 hours

Waving Approaches

Trainee waves approaches under moderate pitching deck conditions with no visible horizon and both with and without plane guard destroyer visible.

III-8 LSORD — 2-3 Trainees — 2 hours

Waving Approaches

Trainee practices waving under pitching deck conditions.

SYLLABUS EVENTS, STAGE IV, MOVLAS:

IV-1 Academic	Group Participation	1 hour

Syllabus Introduction

Topics:

Stage IV overview
Pitching deck review
MOVLAS equipment

IV-2 LSORD	2-3 Trainees	2 hours

Waving Refresher and MOVLAS Introduction

Trainee gets refresher waving under steady deck and moderate pitching deck conditions; introduced to waving with MOVLAS under sterile conditions.

IV-3 Academic	Group Participation	1 hour

MOVLAS Utilization

Topics:

MOVLAS manipulation techniques
LSO comm to pilot
MOVLAS under pitching deck conditions

IV-4 LSORD	2-3 Trainees	2 hours

Waving Approaches

Trainee waves approaches with MOVLAS under sterile conditions.

IV-5 LSORD	2-3 Trainees	2 hours

Waving Approaches

Trainee waves approaches with MOVLAS under moderate pitching deck conditions with well-defined horizon then with reduced horizon.

IV-6 LSORD	2-3 Trainees	2 hours

Waving Approaches

Trainee waves approaches with MOVLAS under moderate pitching deck conditions, both with and without horizon and plane guard destroyer visible.

SYLLABUS EVENTS, STAGE IV (continued):

IV-7 LSORD 2-3 Trainees 2 hours

Waving Approaches

Trainee practices MOVLAS waving skills.

IV-8 LSORD 2-3 Trainees 2 hours

Waving Approaches

Trainee practices MOVLAS waving skills.

SYLLABUS EVENTS, STAGE V, Unusual Waving Conditions and Situations:

V-1 Academic Group Participation 1 hour

Syllabus Introduction

Topics:

Review of prior syllabus coverage
Stage V Overview

V-2 LSORD 2-3 Trainees 2 hours

Waving Refresher

Trainee waves approaches under all conditions introduced in prior stages, including use of MOVLAS.

V-3 Academic Group Participation 1 hour

Unusual Waving Conditions and Situations

Topics:

Aircraft malfunctions and emergencies
NORDO
Ceiling/visibility restrictions
WOD extremes
Ops pressures

V-4 LSORD 2-3 Trainees 2 hours

Waving Approaches

Trainee waves approaches with aircraft malfunctions and emergencies including NORDO.

SYLLABUS EVENTS, STAGE V, (continued):

V-5 Academic	Group Participation	1 hour

Shipboard Experience Seminar

Guided group discussion covering shipboard OJT experiences of trainees.

V-6 LSORD	2-3 Trainees	2 hours

Waving Approaches

Trainee waves approaches with reduced ceiling and visibility and extremes in WOD (crosswinds, high and low velocities).

V-7 Academic	Group Participation	1 hour

Accident Review Seminar

Guided review and group discussion of carrier landing accidents and the role of the LSO in accident prevention.

V-8 LSORD	2-3 Trainees	2 hours

Waving Approaches

Trainee introduced to waving under operational pressure situations such as low fuel state aircraft, missing wires, barricade recovery, loss of radios and FLOLS during approach, etc.

V-9 LSORD	2-3 Trainees	2 hours

Waving Approaches

Trainee practices waving approaches under all conditions introduced in Phase III LSORD training.

V-10 LSORD	2-3 Trainees	2 hours

Waving Approaches

Practice as in V-9.

APPENDIX G

LSORD DATA COLLECTION PLAN

The LSO Reverse Display (LSORD) is a newly acquired device which, for various reasons, has not been utilized very heavily by the LSO community. The findings and recommendations from the study described in this report are based on minimal LSORD utilization. In order to confirm and increase the responsiveness of the LSORD to actual LSO training needs, the results of its use should be reviewed periodically by the LSO Training Model Manager. To support the review effort, data must be collected which reflects trainee and instructor opinions of the device, trainee learning progress, transfer of training to actual job performance and device operability deficiencies. Subsequent paragraphs describe a plan for collection and review of LSORD utilization data.

Since the LSO Training Model Manager is now located at NAS Cecil Field, the procedures in this plan are designed for LSORD utilization at NAS Cecil Field. The procedures could also apply at the NAS Lemoore site if an individual or organization were designated to support the effort.

The general concept of this plan is to provide the LSO Training Model Manager with information concerning LSO trainee performance in the LSORD and aboard ship, as well as data concerning LSORD features and utilization. The LSO Training Model Manager would periodically review the information and would possess a data base for analyses of LSORD training and operating effectiveness.

It is recommended there be three tools for data collection. The first would be a journal located at the LSORD instructor console. This journal is where LSORD session instructors and trainees would document operating discrepancies and recommendations for LSORD feature and utilization (including syllabus) improvement. The second would be a grade sheet for documenting trainee performance in LSORD sessions. The third would be a progress report from the Air Wing LSO concerning trainee performance aboard ship. Reports from the fleet should be submitted on all trainees, not just those exposed to the LSORD. Each of these is described in more detail below.

Every time the LSORD is used for trainee instruction or LSO refresher training, some constructive commentary should be recorded in the LSORD utilization journal. Instructor LSOs and trainees should document several types of commentaries in the journal:

a. Operability discrepancies, such as control and indicator failures, poor visual simulation performance, communications problems, program "crashes", NCLT problems, etc.

b. Adequacy of features to enable effective instructional interaction between LSO and trainee.

c. Adequacy of syllabus lessons and guidance to support effective learning.

d. Recommendations for specific changes to the device which would improve training effectiveness.

e. Recommendations for specific changes to the syllabus which would improve training effectiveness.

f. Particularly successful instructor techniques and strategies which others may find beneficial in conducting LSORD training sessions.

The LSO Training Model Manager or his representative should review the journal at least monthly, or after each period of heavy LSORD utilization. Journal entries will enable the LSO Training Model Manager to initiate or coordinate actions to resolve discrepancies or modify utilization guidelines.

A suggested trainee grade sheet for LSORD sessions is depicted in Figure G-1. This form has been designed not only to document the quality of trainee performance but also to track the trainee's experience with various waving situations. The form is designed to minimize instructor workload in its completion. If a specific syllabus event was being followed this should be identified. Otherwise, the evaluator should provide a brief description of the purpose of the session. Evaluation ratings should be based on how well the trainee performed relative to his experience level. The evaluator is free to rate trainee performance in areas other than those noted on the form. Amplifying comments on trainee performance quality are encouraged. The evaluator should only note waving conditions experienced by the trainee which were a significant aspect of the training sessions. Evaluators should receive guidance from the LSO Training Model concerning the completion of this form.

A suggested traineee progress report for performance aboard ship is depicted in Figure G-2. The content is similar to that of the LSORD grading sheet in that trainee performance quality and waving conditions experienced are recorded. As mentioned earlier, this report should be submitted by the Air Wing LSO on each of his trainees, even those not exposed to the LSORD. This is to allow comparisons between those who experienced the LSORD in their training and those who did not, or who had minimal exposure. Guidance for evaluation is the same as that in the LSORD grading sheet. In accounting for waving conditions experienced, this form requests a differentiation between observation and control. The evaluator is also asked to provide recommendations concerning the LSORD based on experience working with trainees aboard ship. Frequency of report submission should coincide with that of LSO reports specified in LSO NATOPS: prior to extended deployment, mid-point of an extended deployment and conclusion of an extended deployment. The LSO Training Model Manager should receive a copy of the LSO NATOPS report along with the report recommended in this plan.

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Trainee________________________Unit________________________

Date__________

No. of Prior LSORD Sessions __________

Syllabus Event__________ or Session Purpose________________

____

Evaluation (1 = poor, 5 = outstanding):

	1	2	3	4	5
Overall performance					
Recognition of deviations					
Correctness and timeliness of calls					
Pass recall					
Grading					
Other (specify)					

Comments, as desired, to amplify ratings:__________________

____

____

Significant conditions experienced by trainee:

_______ LSO Talkdown _______ Aircraft malfunctions/ emergencies

_______ Pitching Deck _______ Other (specify)__________

_______ MOVLAS _______ Other (specify)__________

Evaluator________________________________ Unit ______

Figure G-1. LSORD Grade Sheet

Trainee ______________________ Unit ______________________

Period covered: ____________________

Approaches: observed _____ day, _____ night
controlled _____ day, _____ night

Evaluation (1 = poor, 5 = outstanding):

	1	2	3	4	5	N/A
Overall performance						
Recognition of deviations						
Correctness and timeliness of calls						
Pass recall						
Grading						
Debriefing pilots						
Other (specify)						

Comments, as desired, to amplify ratings: ______________________
____
____

Significant conditions experienced by trainee:

(OBS)	(CONTR)		(OBS)	(CONTR)	
___	___	LSO Talkdown	___	___	Aircraft malfunctions/ emergencies
___	___	Pitching Deck	___	___	Barricade
___	___	MOVLAS	___	___	Other (specify) ______________

Recommendations concerning LSORD features or use: ______________
____
____

If this is trainee's first reporting period controlling aircraft, give number of approaches observed during this period prior to "getting the pickle": _____ day, _____ night

Evaluator ______________________________ Unit _____

Figure G-2. Trainee OJT Progress Report

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